Thomas Jefferson University

Guide to Laboratory Safety
(Chemical Hygiene Plan)

Developed by:
Thomas Jefferson University
Department of Environmental Health and Safety

In conjunction with:
The Laboratory Safety Committee
Of the University Safety Committee
Thomas Jefferson University

Updated 2013

Thomas Jefferson University

Review Verification Form

This *Guide to Laboratory Safety* has been developed by the Department of Environmental Health and Safety at Thomas Jefferson University to serve as the Chemical Hygiene Plan required by the Occupational Safety and Health Administration's (OSHA) *Laboratory Standard* promulgated in 1990. The intention is to provide guidelines and procedures to everyone associated with laboratories and laboratory related activities.

Annual Chemical Safety Review Verification by Environmental Health Officer	
Verification Date	**Signature**
2013	
2014	
2015	
2016	
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Preface

The Guide to Laboratory Safety has been developed at Thomas Jefferson University (Jefferson) as the Chemical Hygiene Plan required by the Occupational Safety and Health Administration (OSHA) Laboratory Standard promulgated in 1990. The intention is to provide guidelines and procedures to everyone associated with laboratories and laboratory related activities. The goal is to create and encourage a safer work environment.

This laboratory guide can be used as a valuable resource in answering the concerns of employees and students who work and train at Jefferson.

Laboratory employees and students are expected to work and act in a safe, professional manner, implementing the information contained in this guide. Safety awareness and practices then become valuable assets that are taken to any workplace, making research, clinics, and hospitals safer working environments for everyone.

Introduction to Laboratory Safety

Jefferson's research activities and the significant role that laboratory studies have in the education curricula make it essential that the environmental health and safety program address the potential hazards associated with laboratories.

The *Guide to Laboratory Safety* has been developed mainly from existing federal, state, and local regulations and biosafety guidelines from the National Institutes of Health and the Centers for Disease Control. That is not to say that this material is right for every situation. Primarily, it is to be used as a guide from which safe procedures can be developed in specific laboratory settings.

Each laboratory, of course, has its own priorities and concerns, but the responsibilities of laboratory safety require the same effort and concern whether it is research, teaching, or healthcare. The Department of Environmental Health and Safety is available with expertise in the areas of laboratory safety to assist all departments so that reasonable and adequate responses may be found for potential safety hazards. Before initiating work with hazardous chemicals, toxins, or pathogenic biological agents, each laboratory must inform the Department of Environmental Health and Safety (ext. 3-6260) and the Institutional Biosafety Committee (ext. 3-1296) regarding specific University requirements for procedures, precautions, and documentation of these activities.

One of the most serious concerns in laboratory safety is the lack of information about hazards and causes of accidents in laboratories. Laboratory workers are exposed to an impressive list of potential hazards: broken glass, high voltage electronics, pathogenic organisms, uncooperative research animals, radiation, and many substances that are flammable, explosive, corrosive, toxic, and/or carcinogenic.

Safety is an intrinsic part of each laboratory operation, and work should be planned so that exposure to hazards will not occur. The likelihood of injury can be reduced by following established safety measures.

OSHA's Laboratory Standard requires each laboratory to have a Chemical Hygiene Plan. The contents of this Guide adequately fulfill this regulatory requirement. In addition, however, each laboratory must document site specific information, copies of which must be kept on file in the laboratory and in the Department of Environmental Health and Safety. Each laboratory must also develop specific emergency plans as described in Section D of this Guide.

A. LABORATORY SAFETY POLICY ASSIGNMENT OF RESPONSIBILITIES

Policy

Thomas Jefferson University has developed a safety program that ensures a safe workplace, acknowledges the possibility of accidents, and realizes the loss prevention benefits of safety management.

The laboratory safety program includes requirements and recommendations related to the staff, equipment, operation, and maintenance of all activities and facilities. The program is designed to produce a safe working environment and to eliminate or reduce hazards to employees, students, patients, visitors, and the environment.

Program Management

The President of the University has delegated the implementation of the safety program to the Department of Environmental Health and Safety. The Jefferson Safety Steering Committee was established to address health and safety concerns specific to university activities and facilities. This committee reports directly to the Associate Vice President for Facilities Management.

Authority

The Director of Environmental Health and Safety and/or his staff have authority from University Administration to: take prompt corrective action whenever unsafe conditions might exist or when unsafe acts by employees, staff, visitors, patients, or students are observed or reported; inspect all areas of the University to determine safety hazards and recommend corrective actions; audit procedures and job tasks, evaluate risk probability, and recommend corrective actions; evaluate departmental safety efforts and practices. Reports of these activities are provided to administration through various mechanisms.

Principal Responsibilities of the Director of Environmental Health and Safety

- Develop written policies and procedures designed to enhance safety within Jefferson buildings to the maximum degree possible.

- Coordinate and cooperate in the development of individual department safety practices and procedures.

- Establish an accident reporting system that includes mechanisms for investigating and evaluating all accidents reported and for documenting the review of all such reports as well as actions taken.

- Work with the Departments of Facilities Services and Facilities Design and Construction to ensure that project design and maintenance operations include safety provisions consistent with safety regulations.

- Work with the Offices of Infection Control and Radiation Safety through a mutual exchange of information.

- Provide safety-related information to be used in the orientation and continuing education of all employees and students.

- Ensure the periodic inspections of each department.

- Establish methods of measuring results of the safety program at specifically defined intervals.

- Keep current with applicable local, state, and federal safety regulations.

- Keep current with information from major safety-oriented agencies, both governmental and non-governmental.

- Maintain a reference library of pertinent documents and publications dealing with all facets of safety including copies of applicable safety codes and standards.

<u>Principal Responsibilities of Department Heads and Managers</u>

Initial

1. Institute a review of physical facilities, activities, personnel, and procedures in their respective areas for the purpose of:

    a. Identifying the appropriate subdivisions, if any, in their department for efficient administration of the safety program.
    b. Designating an individual(s) as a Safety Observer in order to expedite safety communication within the department.
    c. Reassessing operations to ensure that any actual or potential safety hazards are identified and reported to the Department of Environmental Health and Safety.

2. Familiarize themselves with University policies and regulatory requirements concerning safety.

3. Develop and maintain procedures for continuous attention to safety matters through departmental meetings.

Ongoing

1. Provide safe and healthful working conditions for all employees; conform to safety standards as issued; assure the availability of safety devices and personal protective equipment whenever their use is warranted.

2. Be certain that personnel and their supervisors:

   a. Ensure that provisions for safety are incorporated into every operation and procedure.
   b. Accept as part of their responsibility the safety, not only of the employees reporting directly to them, but also of those persons whose duties from time to time place them in proximity to the areas, operation, equipment, etc. under their jurisdiction.
   c. Ensure cooperation with periodic safety inspections performed by the representatives of the Department of Environmental Health and Safety.
   d. Take prompt corrective action(s) whenever unsafe conditions and acts are noted.
   e. See that all injuries are properly treated and reported.
   f. Investigate and determine the cause of all accidents, even if they result in minor injuries, and make reports as required.
   g. Give personal support to all safety activities and safety procedures brought to the attention of the staff.
   h. Support educational programs addressing safety.
   i. Impart to each employee the understanding that violation of established safety rules will not be tolerated.
   j. Instill safety awareness in each employee through personal and periodic safety contacts and by conducting group safety meetings when warranted.
   k. Post notices to keep employees informed of their rights and duties, including provisions of applicable standards.

<u>Principal Responsibility of Laboratory Supervisor</u>

Laboratory supervisors are responsible for the training of employees in safe practices, for correcting work errors and conditions that may result in personal injury and exposure,

and for developing a positive attitude towards safety in the laboratory. The laboratory safety supervisor must notify the Department of Environmental Health and Safety immediately of the occurrence of any accident that results in an exposure to personnel or the environment.

Principal Responsibilities of Laboratory Compliance Officer

Each laboratory (or group of laboratories) is required to have an individual who is familiar with all aspects of the laboratory's operations. This individual is responsible for ensuring the necessary safety training on the hazards generally present in the laboratory as well as during individual experiments. The Laboratory Compliance Officer is usually the Principal Investigator, or one of his/her designees, and works closely with the Environmental Health Officer and the Biosafety Officer in the Department of Environmental Health and Safety on laboratory safety related issues.

Principal Responsibilities of Laboratory Worker

Each laboratory worker is responsible for complying with oral and written safety rules, regulations, and procedures required for the task assigned. This is necessary for his/her own protection as well as that of fellow workers, the public, and the environment. Each laboratory worker is responsible for reporting to his/her immediate supervisor all facts pertaining to every accident resulting in personal injury or exposure to hazardous and carcinogenic chemicals and also any action that could result in such incidents.

B. THE JEFFERSON SAFETY STEERING COMMITTEE AND LABORATORY SAFETY SUBCOMMITTEE

The Chairman of the Jefferson Safety Steering Committee, chairmen, vice chairmen, and members of its subcommittees are appointed by the President of the University. The Committee reports to the Associate Vice President for Facilities Management who communicates its activities to the President and other Senior Officers of the University. The conclusions, recommendations, and actions of the Committee are reported, via the minutes, to the President and Senior Officers of the University.

The Jefferson Safety Steering Committee meets at least quarterly. It will meet more often if problems or conditions arise which require the attention of the Committee.

Authority of the Jefferson Safety Steering Committee:

1. The Jefferson Safety Steering Committee has the authority to take action, through the Chairman of the committee and Director of Environmental Health and Safety, when conditions exist that pose an immediate threat to life or health or pose a threat of damage to equipment or buildings. This authority to act in emergencies has been approved by the Associate Vice President for Facilities Management.

2. The Committee has formed subcommittees to address: laboratory safety, hazardous materials and wastes, student safety, and emergency preparedness. Subcommittees meet at least quarterly (or as needed) and

report their activities quarterly at the Jefferson Safety Steering Committee meetings.

3. The Committee has the authority to conduct unannounced safety inspections but delegates this authority to the Department of Environmental Health and Safety. Such inspections are conducted with the involved department, laboratory, and facility/service head, or other duly designated representative.

LABORATORY SAFETY SUBCOMMITTEE

The Laboratory Safety Subcommittee is a multi-departmental body. The membership of this subcommittee consists of individuals qualified by training and/or experience to develop safety policies, recommend their implementation, and provide a continuing review of the effectiveness of the laboratory safety program.

Specific responsibilities of the Laboratory Safety Subcommittee include:

1. Serve in an advisory capacity to the Chairman of the Jefferson Safety Steering Committee.

2. Resolve laboratory safety issues brought to the attention of the subcommittee.

3. Review safety inspection reports and make recommendations for implementation as necessary.

4. Analyze pertinent employee, student, patient, and visitor incidents. Advise management of corrective action to be taken to reduce or control incidents.

5. Meet quarterly, and report activities and recommendations to the Jefferson Safety Steering Committee at quarterly meetings.

6. Prepare minutes of the subcommittee meetings which become the official record of activities.

7. Consult individuals with the necessary expertise to address special problems brought to the subcommittee's attention.

C. ESTABLISHMENT OF A SAFE WORK ENVIRONMENT

It is the intent of Thomas Jefferson University and Hospital to provide a workplace that is safe of recognized hazards. Occupational Health and Safety and environmental laws, codes, regulations and standards applicable to Jefferson operations and physical plant will be met.

Safe Work Practices

During New Employee Orientation, all new employees receive general information on the services of the Environmental Health and Safety Department. In addition, information about Jefferson's safety policies and procedures, fire safety, as well as specific information on OSHA's Laboratory Standard, Hazard Communication Standards, and Bloodborne Pathogen Standard is provided. Finally, each department must orient new employees in the proper and safe performance of their duties.

Laboratory employees must attend annual training on laboratory safety. This course is offered monthly throughout the year. **(Registration for this training is available at www.jefferson.edu/ora. From the left hand menu, choose "Professional Development." On the following menu, choose "in class training." A list of classes in date order will appear. Select the course that you want to attend and follow the registration prompts.)**

Written general safety procedures for each department are encouraged. This Standard Operating Procedure (SOP) should include such items as:

1. how to respond to a fire drill
2. the appropriate personal protective equipment (PPE) to wear in the lab
3. how to properly maintain and clean the equipment in the lab
4. who to call to service/repair broken equipment
5. how to clean up a biological spill, both within and outside the Biosafety Cabinet
6. how to clean up a radioactive spill
7. how to clean up a chemical spill
8. how and when to fill out accident reports and where an injured employee should report when an injury or exposure occurs

A copy of these procedures should be available in each lab.

In addition, each Principle Investigator (PI) is responsible for writing the SOPs specific to his work. These SOPs should include the specific steps to be taken to limit or prevent exposure to the specific materials being handled in the lab, whether they are radioactive, chemical, or biological. These SOPs are submitted to the Institutional Biosafety Committee (IBC) for review with the protocol. Once approved, they are to be made available to all individuals working in the lab, **whether they work with the specific material or not.**

Personal Protective Equipment (PPE)

PPE must be worn whenever hazards are present and risk of injury or exposure exists. PPE must adequately protect the user from the potential hazards.

Some examples of when PPE would be necessary are:

a. Lab coats and gloves when working with biohazardous or hazardous materials in a laboratory.
b. Eye protection when splashes of these materials are possible or reasonably anticipated.

c. Eye protection, gloves, and lab coat when cleaning up minor hazardous material spills.
d. Protective toed shoes for employees who handle heavy objects.
e. Hearing protection when working in an environment where the noise levels have been identified as above acceptable standards.

Environmental Health and Safety professionals will work with individual departments to develop criteria for when and what personal protective equipment must be worn. The criteria must be supportable and based on acceptable codes and practices. A review of the departmental accident history and experience can be used in the decision making process. Departments must keep records of their policies and procedures for use of personal protective equipment.

Physical Safeguarding Standards

Machinery and equipment must be guarded to eliminate personal hazards created by points of operation, rotating parts, electrical and power transmission. An employee must not render inoperative a safety device without consulting his or her supervisor and the Department of Environmental Health and Safety.

Federal, State, and Local agencies set standards governing laboratory operations, equipment, and facilities. Some of these are listed below:

a. Occupational Safety and Health Administration (OSHA)
b. National Fire Protection Association (NFPA)
c. National Institutes of Health (NIH)
d. Philadelphia Department of Licenses and Inspections (L&I)
e. Philadelphia Fire Department (PFD)

Conformance with safety regulations must be given careful consideration when evaluating a piece of equipment for use or purchase. The Department of Environmental Health and Safety should be contacted whenever questions arise concerning equipment safeguards.

D. PROCEDURES TO MAINTAIN A SAFE ENVIRONMENT

The Environmental Health and the Biological Safety Officers of the Department of Environmental Health and Safety conduct periodic laboratory inspections of each department, its physical facilities, equipment, and hazards.

The purpose of a safety inspection is to determine what actions are necessary to protect against hazards before accidents and personal injuries occur. Inspections typically concentrate on detecting hazardous physical and environmental conditions as well as hazardous practices. Systematic inspection is the basic tool for maintaining safe conditions and checking unsafe practices.

These inspections are formal and the findings documented. An inspection is considered to be formal when a definite plan and format are followed and conditions are observed in greater detail than in an informal inspection. A report of the inspection is sent to the principal investigator or laboratory manager of the area inspected. The principal investigator and laboratory manager should review the inspection results and schedule corrective actions as appropriate. If a deficiency is found related to the physical facilities, a report is sent to the Director of Facilities Services for corrective action. The Director of Environmental Health and Safety will forward any capital improvements recommended during the inspection through the capital budgeting process. The reports and response actions taken by departments will become part of the record for any internal or external inspections performed by auditors or regulatory agencies. They will serve as documentation of problem areas and as an indicator of progress being made.

A safety inspection is considered to be informal when a brief observation of an area is made. The results and corrective actions taken may or may not be in writing.

Physical plant items needing immediate attention should be reported by a telephone call to ext. 5-6846. This number is staffed 24 hours per day, and should also be called to report any unsafe conditions when it is not advisable to wait for repairs to be scheduled in the normal manner. Examples of items reportable to ext. 5-6846 are:

a. an emergency exit that does not operate properly
b. defective stair and hand rails
c. a malfunctioning electrical outlet
d. a water leak
e. an exit light which is not illuminated
f. heating or ventilation problems
g. malfunctioning chemical fume hoods
h. cylinder restraints

Routine repairs or “non-emergency” maintenance can also be scheduled by calling extension 5-6846. Items involving considerable expenditures must be routed through the appropriate department administrators. Facilities Services personnel make (or schedule with a contractor) regularly scheduled, equipment inspections, which include performing tests of certain equipment. Examples of some items that are given periodic safety inspections are:

a. Fire hose/standpipe systems
b. Interior fire alarm systems
c. Heating, ventilation, and air conditioning systems
d. Smoke detectors
e. Automatic fire sprinkler systems
f. Emergency electrical generators
g. Electrical distribution systems
h. Plumbing systems

Facilities Services personnel may make informal daily inspections of each building. The Security Department also makes informal daily inspections of all buildings. Security Officers patrol the complex 24 hours per day. Defective conditions are reported in writing and the appropriate department notified of the need for action.

Inspections of the facilities are also performed by outside agencies. Jefferson's insurance carriers' safety engineers regularly conduct inspections of the buildings and fire protection systems. The results of these inspections are submitted in writing to the University Department of Risk Management and Insurance. These recommendations are reviewed with the appropriate personnel so that a response can be made to the involved insurance carrier.

If a notice of violation is received from any regulatory agency, the appropriate personnel will be contacted by Environmental Health and Safety so that corrective action(s) can be taken.

Special inspections are also performed to detect hazards which could have a serious health and safety impact and cannot be seen or detected readily prior to them actually being present. For example, a department that uses a toxic gas, which is odorless at hazardous levels, must implement a program to control employee exposure levels to the gas. The equipment containing the gas must be tested for leaks, and employee exposure levels must be monitored. Another example of a special program is the Radiation Safety Program where periodic testing of employee exposures to radiation is performed as well as the calibration of radiological equipment.

Laboratory Safety Pre-inspection Form

Included in **Appendix A** is a self-inspection form for laboratory safety. A representative from the Department of Environmental Health and Safety will periodically inspect each laboratory. The items on the form are those considered very important for maintaining a safe laboratory. A laboratory can use the form at any time as a measurement tool or in preparation for inspection by EH&S.

Emergency Assistance and Safety Concerns List

Included in **Appendix B** is a list containing key contacts and phone numbers that can be helpful in expediting emergency responses or notifying appropriate individuals about safety hazards.

Laboratory Emergency Procedures

The most common types of laboratory emergencies are: chemical and biological spills or leaks; injuries involving chemical burns; fires and explosions; skin absorption, inhalation, or ingestion of chemicals; clothing fires; and electrical shock. Depending on the type of emergency, follow the general procedures listed below:

Fires and Explosions

If a fire or explosion occurs and the fire cannot be instantly extinguished:

a. Rescue anyone in need, evacuate the room and close the door.
b. Pull the nearest fire alarm and call **811** to explain the type of assistance needed and the location.
c. If you feel that the fire can be extinguished AND YOU HAVE BEEN TRAINED TO DO SO, extinguish it with the appropriate class/type of extinguisher. Always position yourself between the fire and the door to ensure an exit path. Otherwise, exit the area.

Laboratory Injuries

In cases of inhalation, ingestion, injection, skin absorption of chemicals or biologicals, clothing fires, and electrical shock, initiate the emergency procedures listed below and follow with first aid measures. Always seek medical evaluation at the Jefferson Emergency Room and have your supervisor complete an accident report.

Eye Exposure **-** If chemicals or other hazardous materials get into the eyes, use an eye wash. Thoroughly flush the eyes with water for at least fifteen (15) minutes. The eyelids may need to be forcibly held open. Every laboratory must have an accessible, ANSI approved eyewash. If your laboratory does not have one, contact the Director of Environmental Health and Safety at extension 3-6260.

Chemical Burns and Skin Absorption – For chemical burns and skin absorption of chemicals, flush with large quantities of cool water or use the nearest safety shower.

Inhalation/Ingestion/ Asphyxiation – In cases of inhalation, ingestion, asphyxiation or suffocation of/from toxic substances, eliminate the source of the problem if possible. In all cases, remove the person from the area and seek medical assistance immediately**.**

Never endanger yourself by entering a contaminated area. Instead, call 811 and give details of the problem to ensure proper emergency response.

Clothing Fires **-** Laboratory personnel must be thoroughly instructed on procedures to follow in the event of clothing fires. The single, most important instruction in such an event is to immediately **STOP, DROP** to the floor**,** and **ROLL**. You also should recognize that, in the event of another person's clothing igniting, you should immediately push that person to the floor and roll the person around to smother the flames. Too often a person will panic and run if his/her clothing ignites, often resulting in serious or fatal burns.

Laboratory personnel should recognize that safety showers or fire blankets are of secondary importance. They should be used only when immediately at hand. They should further recognize that rolling on the floor does not merely smother the fire. It aids in keeping flames away from the face, especially the eyes. Also, inhalation of smoke and heat is greatly reduced.

Electrical Shock **-** Electrical shock requires specific first aid treatment. Initiate CPR if you are trained to do so. Call **811** and explain the type of assistance needed (such as ambulance, transportation to a hospital emergency room, etc.). Follow their directives in assisting the victim to emergency and/or medical care.

Chemical Spills and Releases

The Department of Environmental Health and Safety can recommend spill kits for handling small spills. Wastes from these spills must be disposed through the Chemical Waste Program by calling ext. 3-6260. See **Section R** for proper chemical waste disposal procedures.

For larger spills and leaks involving flammable liquids, toxic or corrosive substances, and for compressed cylinder gas leaks, initiate the following***:***

- Call **811** to report the spill/leak.
- Shut off electrical power to the area or the equipment to eliminate sources of ignition.
- Extinguish all flames, if trained on fire extinguisher usage.
- Increase ventilation by opening doors and windows, if so instructed.

Biological Spills

Detailed procedures for biological spills vary depending upon the agent and quantity that is being worked with. Biological spill procedures can be found in **Section P, Biological Safety.**

Evacuation Procedures - Each laboratory must follow the posted evacuation plan that is located in the elevator lobbies. In addition to fires and explosions, the evacuation plan should also include other hazardous events such as spills, leaks, or releases of flammable, toxic, or radioactive materials and acts of nature, such as tornadoes, hurricanes, and floods.

In addition, each lab must develop the following procedures:

a. under what conditions evacuation will be necessary
b. methods for activating the alarm system
c. actions to be taken (in addition to evacuation) after receiving an alarm such as turning off Bunsen burners and other ignition sources

d. primary and alternate exits leading to the exterior of the building or to designated safe refuge zones

e. instructions to prevent evacuees from hampering fire fighters or emergency responders from proceeding with essential duties (i.e., move away from the building to a pre-designated area)

f. how to determine if everyone has left the facility. Supervisors must check all occupied spaces in their assigned area to ensure that everyone has heard the alarm and is evacuating. Personnel from specific groups, departments, floors or areas should gather in a pre-designated area outside of the building or in a safe refuge zone

g. Special procedures should be established for evacuation of **handicapped persons.**

HANDICAPPED SANCTUARY POINT: High rise or multistory buildings may not have an elevator operating during a fire emergency. Handicapped sanctuary points should be identified on the building evacuation map. Sanctuary points are designated because of their fire protection factor. During building evacuations, these areas will be checked first by the fire/emergency personnel. The use of the sanctuary point offers the most protection when there is insufficient time to evacuate, when evacuation routes are blocked, or when a hazardous material or radioactive release has occurred.

h. Methods to notify personnel when it is safe to return to the facility. (Dependence on duly authorized persons to pass this word will prevent someone from entering the facility prematurely.)

E. EMPLOYEE SELECTION, MOTIVATION, AND TRAINING

It is very important to place an employee in a job that he or she is physically capable of performing. Written job descriptions exist for most jobs within Jefferson. When a job description is prepared, unusual physical demands of that job are to be included in the job description.

Selection

Placing a person in a job for which the physical demands exceed the employee's abilities can lead to accidents. By identifying the demands of the job, the employee can be evaluated during the time of the physical exam. Applicants with disabilities must not be discriminated against.

A description of the working conditions that the employee can be expected to encounter is helpful to the job interviewer and the examining physician if a pre-employment physical exam is given. The job description documents the tasks to be performed. Requirements for safety should be included in the job description.

Each employee is given an employment physical examination at University Health Services. Certain jobs with higher risks of exposure to specific hazards may require that the employee be given a medical evaluation in excess of the standard examination.

Motivation

Motivating employees to properly perform their jobs is largely the responsibility of the supervisor. Properly performing the task includes observing safety procedures, rules, and regulations. Supervisors must stress the requirement that safety rules are to be followed during the performance of a job. During each employee's annual performance appraisal, the supervisor should discuss the employee's safety performance.

It is advisable to document written safety procedures, rules, and regulations. They serve as a record of the required method of performing a job, are available for review by inspecting agencies or parties, and in the event that a person with knowledge of correct procedures is not available, the written rules may be consulted. It is also a good practice to have the employees sign a statement indicating that they have read and understand the safety procedures.

In the event that an employee fails to follow safe work practices, despite corrective action on the part of the supervisor, the Departments of Environmental Health and Safety and Human Resources should be contacted. The task may need re-evaluation and the procedures may need modification. For further information regarding TJU policies on job performance, consult the "Jefferson and You" manual.

Training

It is the intent of Jefferson to assure that employees have the knowledge and training needed to perform their tasks properly and without injury to themselves or others. It is clearly valuable to have well-educated and well-trained employees. It is the PI's responsibility to assure that the employees have been properly trained to perform their assigned tasks.

Each new employee attends New Employee Orientation at which time he/she is given orientation regarding Jefferson policies, practices, rules and regulations. Fire, biological, chemical and general information about safety is also presented to the employee at this session. The name of each employee who has attended the New Employee Orientation and the date of attendance are kept on record in the Department of Human Resources.

The Department of Environmental Health and Safety conducts many types of training programs and updates. For laboratory personnel, there are monthly training classes focused specifically on laboratory safety and compliance with associated regulations. This training is mandatory on a yearly basis for all laboratory workers and it is the responsibility of the principal investigator to ensure that his/her people are trained on laboratory safety. The Department of Environmental Health and Safety maintains training documentation regarding safety and practices specific to the laboratory. **For a list of current laboratory safety training dates, please call extension 3-6260. A list can also**

be found at http://www.jefferson.edu/ora. Registration for classes can be done through this website as well.

Special lectures and presentations may also be given on general safety, biosafety, fire safety, laboratory safety, shipping of biological materials, and hazardous materials handling and disposal. These are usually conducted for those departments which have special physical or logistical conditions and when hands-on demonstration of the subject matter may be necessary. Presentations can also be made between the hours of 5 p.m. and 8 a.m., if requested. These are done on request, or as required by law, or when conditions indicate that such presentations are needed.

The Office of Radiation Safety also provides periodic training on radioactive materials and handling to each employee who works with such materials. Call 5-7813 for more details.

One of the measures available for evaluating the effectiveness of the safety training given to employees is the accident record of the department. The effectiveness of in-service and continuing education programs is to be evaluated at least annually.

F. EQUIPMENT MAINTENANCE

Each department should make an inventory of its equipment. Equipment, which is critical to the proper and safe functioning of the department, should be given "preventive maintenance." For non-critical equipment, "repair maintenance" may be suitable.

Maintenance of the physical plant, facilities, and equipment is handled by several departments and by several methods. General building maintenance is provided by Facilities Services. Housekeeping is provided by Custodial Services (University Buildings) or Environmental Services (Hospital Buildings).

Facilities Services personnel are on duty 24 hours per day to perform scheduled and emergency maintenance. Preventive maintenance schedules have been set for critical equipment. Custodial and Environmental Services can be reached between 5 p.m. and 8 a.m. through the telephone operator at ext. 5-6060.

Most medical and biomedical equipment (including autoclaves and other sterilization equipment) is maintained, serviced, and repaired by Biomedical Instrumentation. In most cases, preventive maintenance schedules have been established for biomedical and patient care equipment. Written records are kept for each piece of equipment. Contact the Department of Biomedical Instrumentation at extension 3-1800 for service requests and additional information regarding their services.

Scientific instruments and office equipment may be maintained through service contracts with outside vendors.

G. SUPERVISOR AND EMPLOYEE PARTICIPATION

Proper performance of a task includes doing it in a safe manner. In the day-to-day functions of the lab, each supervisor is responsible for directing safe work activities.

Safety goals and objectives must be understood and accepted by each department. The supervisor's role in achieving institutional goals and objectives must be accepted and understood.

H. ACCIDENT REPORTING AND INVESTIGATIONS

An accident is an unintended occurrence that caused, or could have caused, personal injury. An injury is an effect on the body as a result of the unintended occurrence, e.g. a cut finger, sprained ankle, chemical burn. The causal factor is the reason why the accident occurred. Reducing and eliminating causal factors is the key to accident prevention.

Supervisors, instructors and managers must complete an Employee Accident Report Form for each accident, injury, exposure or occupational illness (i.e. carpal tunnel syndrome, dermatitis, etc.) reported to or observed by them. They are expected to investigate each incident and properly document their findings on the form. In addition to the form, all accidents must be reported to Environmental Health and Safety's Accident Hotline at extension 5-7233.

<u>Guidelines for Investigating and Reporting Employee Accidents</u>

1) Completing the Accident Report Form:

When an employee or student is involved in an accident, the supervisor or instructor must complete an Employee Accident Report Form. The Supervisor's Section (Section A) should be filled out completely. If information is not available, write "Not Available." The blue copy remains with the department.

The supervisor/instructor will then refer the employee/student to Healthmark between the hours of 7:30a.m. and 4:00p.m. The accident form MUST accompany the individual. Employees with needlestick injuries or blood and body fluid exposures should report to University Health Services between 7:30 a.m. and 4:00 p.m. and the employee must report to the Emergency Room on evenings, weekends, and holidays.

In the event that an employee reports to Healthmark or University Health Services without an accident report form and the injury is found to be work related, the employee must be referred back (when practical) to his/her department where the supervisor must complete the accident report.

Healthmark or University Health Services will complete the physician's section of the accident form and will forward a copy of the form to the Department of Environmental Health and Safety. A copy of the completed form should be turned over to the individual.

2) Investigating the Accident:

The investigation should begin immediately upon notice that an accident has occurred. The supervisor of the employee who had the accident must begin the investigation in order to accurately complete the accident form. In addition, by beginning immediately, facts will be clearer, and the conditions will be clearest to those at the time of the accident. Occasionally, it will be necessary to postpone the questioning of the employee who is, for example, receiving medical attention or is upset.

Every accident offers the possibility of preventing another from occurring at some time in the future and investigating the cause is key to preventing further accidents. The supervisor can play an important role in this process by accurately completing the accident report form. A representative from the Department of Environmental Health and Safety may follow-up with additional investigation and then arrange for correction of any unsafe conditions.

Employee and student accidents are to be investigated and documented by using an Employee Accident Report (form 0155-10 rev. 08/09). These forms can be picked up from either the Jefferson Print Center in the basement of Jefferson Alumni Hall (JAH) or Great Impressions, 1837 Gibbon. Patient and visitor incidents are NOT to be reported on this form. Handwriting must be legible or the form may be returned to the sender for proper completion.

I. RECORDKEEPING TO MEASURE PROGRESS AND IDENTIFY PROBLEM AREAS

Each department administrator determines the level of documentation necessary for that department to properly monitor and maintain its environment and equipment. He/she must also assure that safety documentation is complete and available for accrediting, certifying and regulatory agencies as well as the Department of Environmental Health and Safety.

Written records are useful for measuring progress and identifying problem areas. On an institutional basis, the Departments of Environmental Health and Safety, Facilities Services, Security, Risk Management and Insurance, Hospital Risk Management, and the Office of Radiation Safety keep written records of safety activities performed, of events which have occurred, and of problems reported to them. The records are used to identify trends and special problems.

Some examples of records maintained include:

Daily Safety, Security and Facilities Incidents

Employee Accidents
Fire Reports
Facility Inspections
Safety Committee Minutes
Inspection Reports by Federal, State, and Local Agencies
Chemical, Radiological and Biological Waste Disposal Reports
Reports on Spills and Incidents
OSHA Logs and Rates of Incidents
Patient and Visitor Incident Reports

Upon request, the Department of Environmental Health and Safety is able to send a departmental tabulation of employee accidents to the department head or director of each department on a quarterly basis. Suggestions for corrective actions may be made prior to or after consultation with management.

Patient and visitor incident reports are reviewed by Hospital and University Risk Management and Insurance personnel to observe trends and recommend corrective actions.

Fire reports document the events involving fires and/or the sounding of the interior fire alarm. These reports are reviewed by the Fire Marshal and Fire Systems Shop personnel to identify trends and correct problem areas.

J. MEDICAL EMERGENCY RESPONSE

Jefferson provides medical services at the Emergency Department or University Health Services (for needle sticks and other blood related exposures only) for employees.

Anyone who observes a person being injured or becoming ill on the Jefferson campus should contact the Security Department at **811**. The Security Response Center will dispatch an officer to the site of the medical emergency. The Security Officer will assess the patient's status using the guideline questions contained in the Emergency Department's policies and procedures.

When appropriate, the Security Officer or Supervisor will use the direct phone line to dispatch the Emergency Department team or the Philadelphia Fire Department Paramedics to the scene. The team will attend to the patient, and then arrange for the appropriate mode of transport to the Emergency Department.

When the decision is made that the patient does not need immediate medical attention, the Security Supervisor will assign either the on-site officer or a representative from the Transportation Department (ext. 5-7817) to move the person to the Jefferson Emergency Department.

The Security supervisor/alternate communicates the course of action to the on-site officer via radio. On scene security officer(s) will handle crowd control, allay anxieties, and communicate the course of action until the appropriate responders arrive at the scene. **For more information regarding such emergencies, refer to University Policy No. 119.18 for MEDICAL EMERGENCIES ON THE JEFFERSON CAMPUS.**

K. NON-MEDICAL EMERGENCY RESPONSES

The Jefferson Emergency Response Team comprised of employees of the Departments of Facilities Services, Security, and Environmental Health and Safety, provide immediate response to all non-medical emergencies at Jefferson. Each response is situation dependent and may require the involvement of other departments or outside agencies. For example, in incidents such as fire alarms, smoke and fire, Jefferson is required by law to immediately notify the Philadelphia Fire Department who then responds in a matter of minutes. Other non-medical emergencies include chemical, biohazardous, chemotherapeutic and radioactive spills, accidents, and incidents.

L. DISASTER PREPAREDNESS

Each department must develop a plan that becomes a part of the Jefferson External and Internal Disaster Plans. This plan should define specific actions to be taken if a disaster occurs and should include a personnel call list, which must be updated at least annually.

Jefferson has developed both external and internal disaster plans that address potential and actual emergencies. The Hospital External Disaster Plan is developed and tested by the Emergency/Disaster Preparedness Subcommittee of the Hospital Safety Committee. The University External and Internal Disaster Plans are developed and tested by the Department of Environmental Health and Safety in conjunction with Security, Radiation Safety and other departments. **For more information regarding emergency preparedness, consult the University or Hospital Policies and Procedures manuals or contact the Department of Environmental Health and Safety.**

M. FIRE SAFETY PROGRAM

The Department of Environmental Health and Safety has developed a fire safety program that addresses all aspects of fire safety and offers training to employees upon request. The type of training will vary depending upon the workplace, employee group, etc. Subject matter includes the following areas, but is not limited to those listed.

- Emergency Response
- Fire Alarm System
- Fire Prevention
- Fire Protection
- Fire Drill Procedures
- Fire Evacuation Procedures
- Portable Fire Extinguishers

- Interim Life Safety Measures

Fire Alarms
Upon the activation of a fire alarm, every employee must follow the specific departmental procedures. The frequency of fire drills and proper procedures will vary depending upon building location. Evacuation procedures for drills, as well as fire situations must be followed each time an alarm is sounded. Familiarize yourself on the proper procedures for your building and follow them when an alarm is heard.

Fire Drills: Hospital Buildings

Fire drills are conducted quarterly for each work shift for in-patient care buildings.

The following procedures have been established and will be implemented by the Fire Marshal.

A. The Security Response Center will be notified of the time and location of the drill prior to its initiation.

B. The staff at the selected drill location will be given a scenario of a fire in their area and will be asked to initiate the Code Red procedure.

C. Upon Security's notification of a Code Red in progress, the telephone operator will announce over the public address (P.A.) system "Code Red" and its location 3 times.

D. The Security Response Center will notify the Facilities Services Control Room who will in turn notify members of the Emergency Response Team via radios. Additional Security personnel will be dispatched to the area.

E. Emergency Response Team members responding to the Code Red location will sign an attendance sheet and wait at the location until the Code Red has been declared "All Clear".

F. The operator will be notified when an "All Clear" has been established and will announce "Code Red, (the location), All Clear" three times over the P.A. system.

G. The Fire Marshal will critique the procedures with the Nursing staff and emergency responders following the completion of the drill and will document observations.

Fire Drills: University Buildings

A drill of each building will be conducted twice a year.

Fire drills will be performed in university buildings in the following manner:

A. The Fire Marshal will advise the Facilities Services' Control Room and the Security Response Center of the fire drill, time, and location.

B. A fire alarm pull station will be activated to initiate the drill.

C. Occupants should follow departmental procedures for evacuating the building. If additional information is required, contact Environmental Health and Safety at 3-6260.

D. In buildings with a P.A. system, there will be an announcement of "Fire Drill, All Clear" following the silencing of the bells.

N. GENERAL LABORATORY SAFETY

Personnel Practices:

1. PROTECTIVE CLOTHING - Protective clothing, such as a fully fastened laboratory coat must be worn. Gloves which are appropriate to the specific situation must be used when handling chemicals and potentially infectious items. Disposable gloves shall be discarded after each use, immediately after known contact with a chemical carcinogen, and upon becoming visibly wet with either a chemical or biological material.

Shorts or short clothing are not acceptable laboratory work attire. Sandals and open-toed shoes are also not acceptable.

2. EYE PROTECTION - Devices to provide appropriate eye protection must be worn in any laboratory work area. These include safety glasses, goggles or face shields, whichever is most appropriate for the operation being performed. Eye washes are required in all laboratories where any corrosive chemicals are used or where BL2 research or higher is being performed.

3. HEARING PROTECTION - Ear muffs or earplugs must be worn whenever ultrasonicators and other excessively noisy laboratory equipment are in use.

4. PARAFFIN WAX - In histology tissue processing areas, paraffin fragments frequently fall on the floor. The resultant slippery conditions should be prevented

whenever possible. The use of heavy matting on the floor and holding trays for the paraffin fragments on histology equipment involved in paraffin sectioning are strongly recommended.

5. PIPETTING - Mechanical pipetting aids will be used for all pipetting procedures. **Mouth pipetting is prohibited under all circumstances.**

6. AUTOCLAVES - Open autoclave doors slowly, standing to one side in order to prevent a burn from any residual steam. Wear heat resistant gloves when removing hot items. **Do not attempt to open an autoclave that still contains pressure in the chamber**.

7. EATING, DRINKING, AND SMOKING - Eating, drinking, smoking, chewing of gum or tobacco, application of cosmetics, or storage of food in laboratory areas are prohibited. Food must not be stored in laboratory refrigerators or cold rooms nor can it be heated in laboratory microwaves.

8. PERSONAL HYGIENE - All personnel must wash their hands immediately after completion of any procedures in which biological or chemical materials have been used. In addition, personnel must wash or shower areas of their body which have been in direct contact with either biological or chemical materials. For more detail on hand washing, refer to **Section P**.

9. HOUSEKEEPING - Maintain good housekeeping habits. Do not allow aisles and work areas to become cluttered with chairs, stools, boxes, etc. Aisles must be kept free of obstacles at all times.

10. SAFETY EQUIPMENT - Learn the location and use of fire extinguishers, fire blankets, water hoses, fire alarms, safety showers, and eyewashes.

11. FUME HOODS - Avoid inhaling chemical vapors and gases. Use fume hoods whenever possible. Do not store materials in fume hoods. Keep hoods clear and clean.

12. UTILITIES - Set up experiments so that it is not necessary to reach through the assembly to turn water, gas or electricity on or off.

13. Do not heat a closed system.

14. Use boiling chips when heating liquids to the boiling point.

Glassware

1. Since glass breaks easily, guard against casual handling of glassware. In order to safely cut glass tubing, wear eye protection. Scratch the glass with a triangular file or glass knife. Wrap a towel around the tubing or wear heavy gloves. Place

thumbnails against tubing directly opposite scratch and press while pulling hands apart. Always fire polish tubing ends before using. For tubing with an outside diameter of a centimeter or more, use a cutting wheel or hot wire cutter.

2. Inserting glass tubing into stoppers is easier if it is lubricated with glycerol or water. Wear heavy gloves and use a slow twisting motion.

3. For vacuum traps, use only heavy-walled suction flasks. Wrap adhesive tape around the flask in a crisscross fashion to prevent flying glass in the event of an implosion.

4. When picking up broken glassware, use a brush and dustpan. Fine pieces should be picked up using wet cotton held with tongs. Discard all chipped and broken glassware into a separate, specially marked container. Wear eye protection.

5. Broken glass presents a safety hazard to custodians and other personnel and needs to be properly disposed. When disposing of broken glass place inside a glass disposal box, tape shut, and clearly mark on the outside “Glass”.

Centrifuges

Centrifuge Safety Requirements

All centrifuges and rotors will be used, cared for and maintained in a safe manner. Users' manual recommendations will be followed, and personnel training will be required and documented.

Before using a centrifuge the operator MUST be trained in its proper operation. It is the Lab Supervisor’s responsibility to assure everyone is properly trained before being allowed to operate equipment If you have not been trained in the operation of a centrifuge, DO NOT use one.

Please adhere to the following centrifuge safety guidelines:

1. Keep detailed records of operation for high speed centrifuges and rotors. Do not exceed the maximum speed rating for the rotor.

2. Carefully inspect the condition of the centrifuge tubes prior to ultracentrifugation.

3. Stop the centrifuge immediately if an unusual noise or vibration begins.

4. Keep the lid closed during the entire operation.

5. Always properly balance the materials you are centrifuging.

6. If using nitrocellulose tubes:

   a. Do not use if discolored or flexible.

   b. Storage at 4^{o} C extends shelf life.

   c. Use only in swinging bucket heads.

   d. Do not autoclave; they could explode.

7. When centrifuging biological materials, follow the guidelines noted in **Section P**, **Biological Safety**.

Chemical Handling

Nearly all chemicals are poisonous to the human body to some degree. Flammable liquids, exothermic reactions, unstable materials, toxic, and corrosive materials play a large part in causing injuries. Accidents and the resultant injuries in laboratories can be severe. The following suggestions will aid in reducing the possibility of chemically related accidents.

1. Always ensure the proper labeling of containers with contents, concentration, manufacturer, handling precautions, and expiration date (especially in the case of unstable compounds).

2. "Second skin" type safety coating should be used whenever possible for all bottles containing hazardous materials. These coatings are impact resistant and made from a high tear thermo plastic, providing an added level of safety in the event that a bottle is dropped and broken. The coating works to contain the liquid until it can be transferred to another bottle. This will dramatically reduce spills occurring from bottle breakage.

3. Never test chemicals by taste or odor. If in doubt, do not use an unlabeled chemical.

4. Always remember that acids are poured into water, not vice versa.

5. Large mercury spills should be handled by calling the Department of Environmental Health and Safety. Mercury spill kits for broken thermometers are also available from Environmental Health and Safety.

6. When flammable liquids are to be stirred, use air-driven agitators, not electric motor-driven units. Use a heating mantle or steam bath instead of an electric heating

unit to heat flammable liquids. Concentrations of ethanol above 40% must be stored in safety cans or in an approved flammable storage cabinet.

Collection of Chemical Waste

Check with the Department of Environmental Health and Safety for proper disposal of chemicals. The department operates a weekly chemical collection service for chemical waste. For this service, simply call ext. 3-6260 and leave a message. In general, well-diluted acids and bases (between pH 6 and 9) can be flushed directly down the drain with plenty of water. For more specific information regarding chemical waste disposal, consult **Section R, Hazardous (Chemical) Materials.**

Incompatible Chemicals

Separate storage areas should be provided for "incompatible chemicals," which may react and create a hazardous condition. For example, some oxidizing acids (nitric, sulfuric, perchloric), when stored together with flammable solvents, can create a fire if the bottles are broken and there is contact of the two materials. Do not store chemicals by alphabetical listing. Instead store by acids, bases, salts, flammables, etc.

Cryogenic Liquids

1. Store dry ice, liquid nitrogen, liquid helium, and any other liquefied gases in well-ventilated areas. **Do not store these materials in walk-in cold rooms** as these are not ventilated. The sublimation of dry ice, for example, will reduce the percentage of available oxygen, posing a threat to those who enter.

2. Liquid nitrogen is commonly used for long-term storage of small biological samples. Sample containers can be small glass ampules which are lowered into the liquid nitrogen. Improper sealing of the ampules can cause an explosion upon removal from liquid nitrogen temperatures. To prevent this, always test the ampules for tight-sealing by placing in a dye solution for two minutes prior to freezing.

3. When removing a sample container from the liquid nitrogen, wear safety goggles, lab coat, and insulated gloves. Quickly place the ampules in a beaker of warm water inside a Styrofoam ice bucket, and cover immediately. All these precautions can be obviated by the use of the plastic vials available and designed specifically for cryogenic use. While these vials may occasionally crack if not sealed properly, they rarely explode as the glass ampules did in the past.

Needles and Syringes

Needle punctures are one of the most frequent laboratory related injuries. Incidents involve laboratory workers, maintenance and custodial personnel. Discarding of needles in wastebaskets is prohibited. A specially marked, impervious plastic container (sharps container) is to be used for disposal of all needles and syringes.

It is strongly recommended that cannulas be used, if a sharp needle is not needed. Needles must never be left lying about without the plastic guards in place. Needles must never be recapped unless under certain conditions where an approved needle-capping device or method can be used. Destroying needles by clipping or "shearing" is prohibited because the potential for hazardous aerosols exists. **Refer to Section P for additional information covering needles and syringes.**

O. HAZARDOUS MATERIALS AND WASTE CONTROL PROGRAMS

At Jefferson, hazardous material is defined as any material that is potentially harmful to man, other animals or to the environment, in any concentration by physical, chemical or infectious means. Hazardous waste is defined as any material that meets the criteria for hazardous material and is accumulated, stored, or chemically or physically treated prior to disposal.

There must be organized plans to control the receipt, use, and disposal of hazardous materials. These plans must comply with Federal, State, and Local regulations.

Each department which uses hazardous materials must establish procedures for their receipt within the University. Certain materials require that the user be licensed and/or certified to use the materials. The use of hazardous materials produces hazardous waste which must be properly disposed. When a department/service has hazardous chemical waste such as chemotherapy or other chemicals for disposal, it must contact the Department of Environmental Health and Safety. The Environmental Health Officer will prepare it for shipment and oversee the proper removal and disposal by an EPA licensed contractor. Whenever possible, minimization, recycling, fuel blending and incineration will be designated as disposal techniques of choice to assure resource conservation and waste volume reduction.

Custodial Services arranges for removal of regular trash, infectious waste, and sharps from all buildings except Gibbon, Foerderer Pavilion, Thompson, Main, and JHN where these wastes are handled by Environmental Services.

NOTE: Specific policies and procedures for waste disposal are available from each department with corresponding responsibility. In addition, University Health Services develops, administers, and provides training to all potentially affected employees for infectious disease precautions including hepatitis B virus (HBV) and human immunodeficiency virus (HIV, AIDS) exposures.

Hazardous materials and hazardous waste fall into the basic categories of biohazardous (infectious/pathological), chemical (flammable, corrosive, toxic and reactive) and radiological materials. Procedures for properly handling and disposing of these materials are included in sections P through T.

P. BIOLOGICAL SAFETY

The most important element of containment of infectious materials is strict adherence to standard microbiological practices and techniques. Persons working with infectious agents or infected materials must be aware of potential hazards and be trained and proficient in the practices and techniques required for safely handling such material.

Procedures for Biohazard Control

Each laboratory supervisor must develop or adopt safety and operational procedures to identify the hazards that will, or may likely, be encountered. They must also specify practices and procedures designed to minimize or eliminate identified risks, as well as the procedures to be used in the event of an accidental exposure. Personnel must be required to read and follow the established practices and procedures and must be advised of any special hazards present in the laboratory.

Institutional Biosafety Committee

At Thomas Jefferson University, the Institutional Biosafety Committee (IBC) exists to ensure that research involving recombinant DNA and pathogenic agents is assigned the appropriate Risk Group (biosafety level) and that all work is conducted in accordance with National Institutes of Health (NIH) guidelines. Additionally, the IBC ensures that research protocols are carried out in a manner which complies with the Occupational Health and Safety Administration's (OSHA) Bloodborne Pathogens Standard.

Members of the IBC are appointed annually by the President of Thomas Jefferson University in accordance with NIH guidelines. Each member serves for a minimum of three years. The IBC meets monthly to review research protocols. (Please see the IBC's *Policies and Procedures* at www.jefferson.edu/ohr/ibc under Policies, Submission Procedures)

OSHA Bloodborne Pathogens Standard

Any laboratory which works with potentially infectious material (i.e. blood, tissue, viruses, etc.) must comply with the Occupational Safety and Health Administration's *Bloodborne Pathogens Standard.* Under this law, the employer is required to ensure that the laboratory employee is trained on appropriate methods to control accidental exposure to potentially infectious agents. Employers must communicate the potential hazards,

provide employees with appropriate personal protective equipment (gloves, eye protection, face shield etc.) and ensure these are used whenever the potential exists for accidental exposure.

Additionally, each employee who is covered by the standard must also be offered a Hepatitis B vaccination by the employer at no cost to the employee. Employees may refuse the vaccination. If they choose not to receive the vaccine, they must sign a declination form provided by the employer. Additional vaccinations are available to employees who come into contact with other infectious agents such as rabies, vaccinia virus, etc. All vaccinations are available to employees at no charge. For more information on the Bloodborne Pathogens Standard and associated vaccinations, contact the Biological Safety Officer at extension 3-7422.

Routes of Transmission

Exposure and potential infection from biological material can occur by one or multiple forms of direct contact between the laboratory worker and an organism. For these reasons, workers must always be on guard against the following types of exposure and must take adequate measures to reduce the risk to the following types of contact.

Respiratory Route Infection

A variety of agents infect by the respiratory route. Aerosol generation and dissemination can be reduced by the following:

1. Properly operating laminar-flow biological safety cabinets for protection against immediately generated aerosols.

2. Thorough decontamination of work surfaces before and after work as well as following spills of biohazardous material. This method is particularly effective in preventing secondary aerosols generated by agents resistant to drying.

3. Use of absorbent materials on immediate work surfaces, to contain splashes and drips.

Infection by Ingestion

A variety of organisms used in the laboratory are enteric pathogens which use ingestion as the primary route of infection (intestinal parasites, Salmonella, agents of infectious hepatitis, polio virus, and enteropathogenic *E. coli* strains). Infection by these organisms generally occurs in the following ways:

1. Direct ingestion of the culture by mouth pipetting. Pipetting by mouth is prohibited in all situations.

2. "Hand to mouth" infection whereby infectious materials are indirectly transferred by the hand to the oral cavity. Activities such as smoking, eating, and drinking are therefore prohibited in laboratories. Frequent hand washing with germicidal soap between activities is strongly recommended.

Needlesticks, Punctures, Contact with Non-intact Skin

1. Contact can be avoided by limiting the use of needles and syringes. The use of safety needles/devices must be used when applicable.

2. Using non-breakable containers whenever possible will also reduce the potential for puncture incidents.

3. Workers' hands must never come into direct contact with infectious agents. Therefore, gloves must be worn and discarded appropriately before handling other equipment or objects.

Exposure to Mucous Membranes

1. All manipulations capable of generating a splash or spray must be conducted within a biological safety cabinet with the sash and seat properly adjusted to afford protection of the eyes.

2. Manipulations which may create splashes and that cannot be conducted within a biological safety cabinet (e.g. disposal of disinfected liquid waste to the sanitary sewer) must be performed while wearing eye protection and a mask (to protect the nose and mouth) or a full face shield. Work can also be conducted behind an acrylic splash shield; however, this must be adequately sized to provide ample protection against eye, nose and mouth exposure.

Absorption

1. Exposures via permeation of the skin. The material enters the body through pores in the skin.

2. For most manipulations, the most vulnerable area to absorption is the area between the end of your glove and the beginning of your lab coat. Therefore, it is always a good idea to wear a lab coat that has a ribbed cuff and fits down over the cuff of the glove.

Operations and Equipment to Minimize Exposure

Hand washing

One of the most effective methods of protection against accidental exposure to potentially infectious agents is executed every time an individual washes his/her hands. Hand contamination with transient microbes (some of which can be pathogenic) can easily occur during manipulation of specimens, equipment and supplies as well as from contact with work surfaces. For these reasons, it is important that all laboratory personnel wash their hands:

a. whenever they come on duty

b. when leaving the laboratory for whatever reason

c. when hands are obviously soiled

d. before and after completion of a task in a biological safety cabinet, even if gloves are worn

e. after handling animals, their toys, waste, or bedding

f. upon completion of tasks

Standard hand washing protocol:

1. Turn on the faucets and wet the hands using warm water.
2. Dispense antiseptic soap compound into a cupped hand.
3. Spread the soap around both hands and between the fingers. If needed, add a small amount of water to facilitate spreading and lathering.
4. Wash the hands for approximately 20 seconds. Vigorously rub both sides of the hands beginning a few inches above the wrists and moving downward between the fingers, around and under the fingernails.
5. Rinse thoroughly under warm water beginning with the area above the wrists and continuing downward past the fingers.

If the sinks are foot, knee or elbow operated, turn off the water. If not, leave the water running, dry the hands with paper towels and then use the towel (as a barrier to your clean hand) to turn off the faucet.

Pipetting

Mouth pipetting is prohibited in all situations. Use one of the mechanical aids that are commercially available. Delivery must be accomplished with the tip of the pipette resting against the container, allowing the fluid to flow down the surface thereby minimizing aerosols. In addition, the following practices must be observed:

1. No infectious mixture should be prepared by bubbling air through the liquid with the pipette.

2. No infectious material should be forcibly discharged from a pipette.

3. Placing a disinfectant soaked towel over the immediate work surface is useful in minimizing aerosolization from accidental splashing.

Use of Syringes and Needles

To reduce the risk of accidental injection, aerosol production or spills, the following practices must be observed:

1. Restrict the use of needles and syringes for practices in which no alternative is available, such as parenteral injection, phlebotomy, or aspiration of fluids from laboratory animals and diaphragm bottles. Use safety needles/syringes when applicable.

2. Do not use a syringe and needle as a substitute for a pipette in making dilutions of hazardous or infectious fluids. Syringe-type pipettes with blunt-ended delivery are preferable.

3. Reusable or disposable syringes used with biohazardous materials should be of the LEUR-LOK or equivalent type to assure that the needle cannot separate during use.

4. Used disposable needles must not be bent, sheared, broken, recapped, or removed from disposable syringes.

5. Disposable needles and syringes must be disposed as a single unit into puncture-resistant leak-proof “sharps” containers. Full containers must be sealed and placed into the red bag waste stream for disposal. Refer to waste disposal guidelines, **Appendix C**.

6. Syringes not associated with needles or which have not come into contact with biohazardous material must also be disposed into sharps containers for disposal. Syringes and needles must never be discarded into the regular waste stream.

7. Never discard syringes and needles into pans containing pipettes or other glassware which must be separated from syringes and needles.

Use of Centrifuges and Shakers

To reduce the opportunity for aerosol production of biological material when using centrifuges and shakers, the following practices must be observed.

1. All tubes must be capped.

2. Biohazardous agents must be centrifuged in an enclosed centrifuge with sealed rotor. Safety cups and rotors with covers and O-rings are both effective at minimizing aerosol production.

3. Decanting from centrifuge tubes must be performed in a biological safety cabinet.

4. When mixing broth cultures utilizing a Vortex or similar mixer, avoid wetting the plug or cap of the tube.

5. As an additional safety measure, centrifuges and shakers are not permitted in corridor areas and must be housed within laboratory or common equipment spaces.

Note: Items for centrifugation should always be balanced to avoid vibration, which can result in failure of the unit as well as considerable aerosolization.

Opening Culture Plates, Tubes, Bottles, and Ampules

Aerosols are produced when contaminated plugs or screw caps are removed from tubes and bottles. Employing good, sterile technique when opening tubes, bottles and culture plates will minimize the potential for aerosolizing the culture.

Opening ampules is also potentially hazardous after the seal has been broken because air rushing in causes the dry contents to be dispersed.

1. After scoring the ampule with a file, wrap it in cotton that has been wet with disinfectant. Wear gloves.

2. If a disinfectant may damage the culture, use a biological safety cabinet and the following procedure:

   After scoring the ampule with a file, apply a hot, glass rod to the mark. The glass will crack, allowing air to enter the ampule and equalize the pressure. After a few seconds, wrap the ampule in a few layers of tissue, and break it along the crack. The tissues and ampule neck must be discarded appropriately.

Employing good, sterile techniques when opening tubes, bottles and culture plates will minimize the potential for aerosolizing the culture. Also, it is recommended that a culture plate be open so that the lid is between you and the culture medium.

Blenders, Ultrasonic Disintegrators, Grinders, Mortars and Pestles, and Homogenizers

Blenders, disintegrators, grinders and homogenizers release considerable aerosols during their operation.

1. Blending, grinding, and homogenizing must be performed within a biological safety cabinet.

2. Disinfectant-soaked absorbent material can be placed over the blender during operation to further reduce the production of aerosols.

Water Baths and Warburg Baths

It is recommended that water baths and Warburg baths used to inactivate, incubate or test biohazardous materials, contain a disinfectant such as Clorox or a phenolic detergent. Water should be changed at frequent intervals.

Laboratory vacuum lines

When a laboratory vacuum is used to manipulate biohazardous materials, a flask containing a suitable disinfectant must be employed to ensure that the building vacuum lines do not become contaminated. Clorox, added such that the final concentration will equal 10%, is a suitable agent. The flask should be placed in a secondary container to contain any leak or spill in the event that the flask cracks or is broken. An inline filter must also be present between the flask and vacuum line. Empty all flasks frequently and whenever more than 3/4 full.

Contaminated Glassware (flasks, beakers, reusable pipettes, etc.)

Contaminated glassware and similar materials which will be used again must be disinfected before washing.

Labeling

Storage vessels containing biohazardous agents must be labeled to provide identification of their contents. These labels should contain as much information as possible so that the contents are immediately identifiable to anyone; not just the person consigning them to storage.

Equipment used for the manipulation or storage of biohazardous material must be labeled with a biohazard sticker and a description of contents (e.g. human cell lines).

Contaminated Materials

Contaminated materials that are transferred from work sites to decontamination and disposal staging areas shall be properly labeled with the individual's name and transported in a manner that prevents accidental spills.

Containers

Non-breakable impermeable closed containers must be used during transport of biohazardous material through a building corridor or between buildings.

Personal Protective Equipment (PPE)

A lab coat and adequate personal protective equipment (i.e. gloves, goggles, face shields, etc…) must be worn to protect employees from exposure to biological agents. Lab coats and PPE **must NOT** be worn outside the laboratory or to public eating areas.

Refrigerators, Deep Freezers and Dry Ice Chests Used to Store Biological Material

1. Refrigerators, deep freezers, and dry ice chests must be checked, defrosted and disinfected periodically. Remove any samples which may have broken during storage.

2. Equipment containing potentially biohazardous material must be locked at all times when stored outside of the laboratory in a hallway or common equipment area. Placement of this equipment must comply with the requirements of the university corridor storage policy (Policy # 119.28). Such equipment must also be labeled with the name and telephone number of a contact individual, as well as the laboratory room number, in the event of an equipment failure.

3. When closing down a lab, all equipment used to store potentially biohazardous material MUST be emptied out, the material properly disposed of, the inside of the equipment decontaminated with a 10% bleach solution, and any markings or biohazard labels defaced or removed.

Class II Biological Safety Cabinets

General Information

Increasing numbers of biomedical researchers at Jefferson are conducting investigations that require a high degree of contamination control. The Class II cabinet, also known as the biological safety cabinet, provides protection of personnel as well as the product. The cabinet has an open front with inward air flow for

personal protection. Air flowing downward over the working surface is filtered by a high efficiency particulate air (HEPA) filter for product protection. The cabinet exhaust air is also filtered through a HEPA filter.

Cabinet Usage

The Class II Type A biological safety cabinet is used when working with infectious agents requiring Biosafety Level 2 or 3 containment. It is not for use with volatile or toxic chemicals or radionuclides, since the HEPA filtered cabinet exhaust is discharged into the workspace.

The Class II Type B biological safety cabinet differs from Type A in that it is hard ducted to the exhaust system and has an increased face velocity. These features allow for work with small amounts of toxic chemicals and radionuclides in addition to infectious agents.

Effectiveness

The effectiveness of Class II cabinets in controlling contamination depends on:

a) The integrity of the filter
b) Filter housing
c) The uniformity of air flow
d) Proper decontamination methods

Certification/Decontamination

All biological safety cabinets must be certified (to be working correctly) at least once each year or whenever the equipment is relocated.

Decontamination of a biological safety cabinet must be performed prior to moving the equipment. It is also recommended whenever the use of the cabinet changes.

Consultation

Consultation regarding purchase, installation, testing, certification or decontamination of biological safety cabinets can be arranged with the Department of Environmental Health and Safety at extension 3-6260.

Posting of Biological Hazard Signs

Purpose

The necessity for establishing policies and procedures for proper identification of hazardous biological agents within the University laboratories is to alert support

personnel who may enter the area to take precautionary measures and to restrict traffic to potentially hazardous areas.

Responsibility

It is primarily the responsibility of the Principal Investigator (PI) to properly identify biohazards. Upon determination that a potential biohazard exists, the PI should notify the Department of Environmental Health and Safety.

Biohazard Warning Sign

To ensure proper identification, a standardized, easily recognized sign is essential.

For the purpose of issuance, the term "biohazard" includes only those infectious agents presenting a risk or potential risk to the well-being of a human.

The warning sign shall be prominently placed so that it can be easily seen and shall be displayed ONLY for the purposes of signifying the presence of actual or potential biohazardous agents.

Procedures

Before research of a biohazardous nature is begun or when it is determined that a biohazard exists:

1. Requests for biohazard signs must be made to the Department of Environmental Health and Safety.

2. A review of the required information to appear on the sign will be conducted with the PI before any signs are provided.

Recommended Biosafety Levels for Infectious Agents and Infected Animals

The selection of an appropriate biosafety level or work with a particular agent or animal study is dependent upon a number of factors.

The most important of these include the:

a) Virulence, pathogenicity, biological stability, and communicability of the agent
b) Nature or function of the laboratory
c) Quantity or concentration of the agent
d) Endemicity of the agent
e) Availability of effective vaccines or therapeutic measures
f) Documented or suspected route of transmission of the agent

In general, the biosafety level used for activities involving infectious agents or infected animals must be commensurate with that required for the agent of highest virulence known, or likely to be encountered in the course of the contemplated work. For example, all material of human origin, including cell lines, tissue, and blood, must be considered potentially infectious for hepatitis and HIV and handled under Universal Precautions, which reasonably preclude cutaneous, oral, and parenteral exposure to personnel.

If, in the course of diagnostic or other laboratory examination, there is evidence that the materials being studied contain an agent of higher or lower risk than expected, the biosafety level can be raised or lowered accordingly.

Occasions will arise when it will be necessary to assign a biosafety higher than that recommended in these guidelines. For example, a higher biosafety level may be indicated by the unique nature of the proposed activity (e.g., the need for special containment for experimentally generated aerosols for inhalation studies).

It is the responsibility of the Principal Investigator to inform the Institutional Biosafety Committee (IBC) as well as the Department of Environmental Health and Safety (EH&S) when he or she begins to work or ceases to work with any agents at the BL-2 or BL-3 levels.

Summary of Laboratory Practices for Each Biosafety Level

Biosafety Level 1

This level is suitable for work involving agents of no known or of minimal potential hazard to laboratory personnel and the environment. The laboratory is not separated from the general traffic patterns in the building. Work is generally conducted on open bench tops. Special containment equipment is not required or generally used. Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science.

Biosafety Level 2

This level is similar to Level 1 and suitable for work involving agents of moderate potential hazard to personnel and the environment. It differs in that (1) laboratory personnel have specific training in handling pathogenic agents and are directed by scientists competent in this biosafety level, (2) access to the laboratory is limited when work is being conducted and (3) certain procedures in which infectious aerosols are created are conducted in biological safety cabinets or other physical containment equipment.

Biosafety Level 3

This level is applicable to clinical, diagnostic teaching, research, or production facilities in which work is done with indigenous or exotic agents which may cause serious or

potentially lethal disease as a result of exposure by the inhalation route. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents and are supervised by competent scientists who are experienced in working with these agents. All procedures involving the manipulation of infectious material are conducted within biological safety cabinets or other physical containment devices or by personnel wearing appropriate personal protective clothing and devices. The laboratory has special engineering and design features. It is recognized, however, that many existing facilities may not have all the facility safeguards recommended for Biosafety Level 3 (e.g., access zone, sealed penetrations, directional airflow, etc.). In these circumstances, acceptable safety may be achieved for routine or repetitive operation (e.g., diagnostic procedures involving the propagation of an agent for identification, typing and susceptibility testing) in laboratories where facility features satisfy Biosafety Level 2 recommendations provided the recommended "Standard Microbiological Practices," "Special Practices" and "Containment Equipment" for Biosafety Level 3 are rigorously followed. The decision to implement this modification of Biosafety Level 3 recommendations may only be made by the Institutional Biosafety Committee. At Jefferson, entry into a BL-3 facility is restricted to those individuals who have had training and have demonstrated knowledge of BL-3 Standard Operating Procedures and Safety Practices by means of a written exam.

Biosafety Level 4

This level is reserved for work with dangerous and exotic agents which pose a high individual risk of life-threatening disease. No work is performed with agents requiring Biosafety Level 4 containment at Jefferson.

Summary of Classification of Biological Agents According to Risk

Biological Agents are assigned an applicable biosafety level according to their risk. For a comprehensive list of agents and respective biosafety levels, consult the latest editions of the National Institutes of Health's *"Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules"* and the Centers for Disease Control / National Institutes of Health's *"Biosafety in Microbiological and Biomedical Laboratories"*. You can also contact the Biological Safety Officer in the Department of Environmental Health and Safety at extension 3-7422.

Respiratory Protection Program for *M. tuberculosis*

Appropriate respiratory protection (filtration masks approved by the National Institute of Occupational Safety and Health [NIOSH] for TB protection) must be worn by persons potentially exposed to M. tuberculosis in settings where administrative and engineering controls may not provide adequate protection. Such settings include TB isolation rooms and areas in which patients who may have infectious TB are undergoing cough-inducing or aerosol generating procedures. Appropriate respiratory protection must also be made available to individuals working with TB positive diagnostic samples in clinical settings, for the purpose of emergency cleanup procedures.

A representative of the Department of Environmental Health and Safety will supervise the selection and use of respirators based on the type of hazard, the conditions for potential exposure and the severity of the potential exposure.

Cell Culture Systems

General Information

Cultured cells are a routine source material in many research laboratories. Most cultured cells are known to harbor viruses either adventitiously (in many cases of detectable C-type particles) or deliberately (as in the cases of SV40 transformed rodent and human cell lines or human lymphoid cell lines, which are transformed by Epstein-Barr virus).

Long term culture of cells may enhance the risk of rescuing an oncogenic agent, whereas an autonomous infectious virus is more likely to be released upon short-term manipulation (two to three weeks) of freshly isolated cells.

It is therefore prudent to adopt Universal Precautions for the handling of cultured cells. All cell manipulations should be performed in a biological safety cabinet using BL-2 practices and procedures, including the use of personal protective equipment such as gloves, while wearing a buttoned lab coat.

Shipment of Diagnostic Specimens and Infectious Substances*

*Adopted with modification from the latest edition of the International Air Transport Association (IATA) publication "Dangerous Goods Regulations."
Definitions:

Infectious Substances: Substances which are known or are reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsiae, parasites, fungi) and other agents such as prions, which can cause disease in humans or animals.

Biological Products: are those products derived from living organisms which are manufactured and distributed in accordance with the requirements of appropriate national authorities, which may have special licensing requirements, and are used either for prevention, treatment, or for development, experimental, or investigational purposes related thereto. They include, but are not limited to, finished or unfinished products such as vaccines.

Cultures: are the result of a process by which pathogens are intentionally propagated. This definition does NOT include patient specimens.

Patient specimens: are those collected directly from humans or animals, including, but not limited to, excreta, secreta, blood and its components, tissue and tissue fluid swabs, and body parts being transported for purposes such as research, diagnosis, investigational activities, disease treatment and prevention.

Medical or Clinical Wastes: are wastes derived from the medical treatment of animals or humans or from bio-research

Genetically modified Micro-organisms and Organisms: are micro-organisms or organisms in which genetic material has been purposely altered through genetic engineering in a way that does not occur naturally.

Shipper's Responsibility

Investigators must be aware that all the above materials are subject to specific shipping regulations. The Shipper must properly classify a substance as either Category A, Category B, or Exempt and properly package, label and document all shipments. The Shipper's responsibility does not end when the Carrier accepts the package. The Shipper's responsibility ends when the package is signed for at its destination indicating that it arrived in good condition.

Training and Consultations

It is required that anyone who is responsible for shipping diagnostic specimens or infectious substances attend training conducted by Environmental Health and Safety.

Training and consultation regarding the classification, packaging, marking, labeling, and documentation of biological shipments can be arranged with the Department of Environmental Health and Safety at extension 3-7422 or by registering for a training class via the website at http://www.jefferson.edu/ora.

Emergency Response

Biological spills inside a Biological Safety Cabinet

1. Leave the cabinet operating in order to contain aerosols.

2. Initiate cleanup as soon as possible with a suitable disinfectant such as 10% Clorox.

3. Items within the cabinet should be wiped carefully, with disinfectant.

4. Allow the cabinet to run at least 10 minutes after cleanup before activity is resumed.

Biohazard spills outside of a Biological Safety Cabinet

The following procedure should be followed in the event of a spill of a Biosafety level 1 or 2 agent outside of a biological safety cabinet:

1. Notify others of the spill.

2. Remove any contaminated clothing and wash any affected body parts with a disinfectant soap.

3. Wearing personal protective equipment (gloves, goggles, Tyvek suit, etc…), soak paper towels in straight Clorox or other appropriate disinfectant. Place the paper towels on the spill. Cover the paper towels with a "diaper" (absorbent on one side, plastic-backed on the other side), such that the absorbent side is in contact with the paper towels. Allow at least twenty minutes of contact time.

4. Remove toweling, and wipe entire area with 10% Clorox, followed by 70% ethanol.

5. Dispose of all cleanup materials as biohazard waste.

The following procedure should be followed in the event of a biohazard spill of highly infectious material, such as a Biosafety Level 3 agent:

1. Notify others in the room that a spill has occurred.

2. Remove contaminated protective garments (including shoes) and leave the room.

3. Wash any affected body parts with disinfectant soap.

4. Notify the Emergency Response Team by calling "**811**".

After the above immediate actions are accomplished, decontamination and cleanup will be directed by the laboratory supervisor and the Emergency Response Team as follows:

1. Before reentering the affected area, wait a minimum of 30 minutes to 2 hours, depending on the nature of the spill, to permit settling and reduction of airborne particles.

2. Personnel involved in the cleanup should put on disposable Tyvek suit, head and foot coverings, a mask, eye protection, and medium to heavy weight rubber gloves.

3. Soak paper towels in straight Clorox or other appropriate disinfectant. Place the paper towels on the spill. Cover the paper towels with a "diaper" (absorbent on

one side, plastic-backed on the other side), such that the absorbent side is in contact with the paper towels. Allow at least twenty minutes of contact time.

4. Using a disposable dustpan and squeegee, transfer all materials from the spill area to a biohazard waste container.

5. Wash and mop the spill area and adjacent areas with disinfectant-detergent solution.

6. Gas sterilize equipment that requires decontamination but cannot be subjected to liquids or heat. This will be arranged by the Department of Environmental Health and Safety.

7. Before leaving the immediate area, the decontamination team should remove shoe covers and wipe shoes on pads soaked with disinfectant solution. All personal protective equipment must be disposed of as biohazard waste. Personnel should then shower using a germicidal soap.

8. The laboratory supervisor should assure that all waste, equipment, and clothing is properly decontaminated or disinfected and disposed of as biohazard waste.

Biohazardous Waste

The following categories are considered potentially infectious by definition according to the Pennsylvania Department of Environmental Protection and must be packaged as biohazardous waste items. A puncture resistant, leak proof container lined with a red bag is used for this purpose. Approved bags and containers can be obtained by contacting the Custodial or Environmental Services supervisor for your building. For specific questions on the disposal of biohazardous material, call the Biological Safety Officer at extension 3-7422.

Biohazardous Waste Definitions

Waste material which meets any of the following definitions must be disposed in a responsible safe manner.

Human Waste	All human blood, tissues, body fluids, secretions, excretions, organs, and cadavers. All items contaminated with human waste are also considered to be infectious biohazard waste, even when the source patient is not known to have a communicable disease or to be on Isolation Precautions.
Sharps Waste	All needles, syringes (with or without the attached needle), Pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, culture dishes, suture needles, slides, cover slips and other broken or unbroken glass or plastic ware.

Microbiological Waste All materials containing or in contact with cultures of microbiological organisms and all patient specimens sent for microbiological culture or items contaminated by patient specimens.

Biological Materials Waste All discarded vaccines, immunoglobulins, plasma, albumin, blood or tissue fractionation products, enzyme preparations, etc.

Animal Waste All animal carcasses, tissues, blood, body fluids, and all items grossly contaminated with these items.

Animal Pathogen Contaminated Waste All bedding and other materials contaminated with blood, excreta or secretions of animals infected with transmissible human or animal pathogens.

Decontamination, Sterilization, Disinfection

All biohazardous waste must be rendered non-infectious prior to final disposal. While Biosafety Level-3 and the higher risk BL-2 agents must be autoclaved prior to further processing, most infectious material can be disposed safely through proper handling and packaging. Please refer to Appendix C for proper waste disposal.

Each generator of biohazardous waste has an obligation to handle and dispose their material in a manner that affords protection from leakage, exposure, or injury to service personnel handling their waste material.

1. Each individual working with biohazardous material or contaminated items is responsible for their decontamination, disinfection, and appropriate preparation prior to disposal or reuse.

2. All laboratories, in which work with biohazardous materials is carried out, must have labeled, leak-proof, covered containers for temporary holding of infectious materials awaiting disinfection or disposal. These containers MUST be kept closed, except when waste is actively being disposed.

3. When autoclaving:

    a) test tape or another suitable indicator must be used on each load placed in the autoclave. This will aid in determining which items have been sterilized.

b) waste bags must be marked with the room number from which the waste originated.

c) bagged waste must be placed into a containment pan prior to autoclaving. The purpose of the containment pan is to prevent release of material in the event that the bag loses its integrity during the cycle. This prevents waste from building up within drainage pipes, allowing for proper function of the autoclave.

d) only approved autoclavable bags are to be used. Red bags are reserved for incineration, and are not acceptable for autoclaving.

e) autoclaves may only be operated by trained individuals. Operators must never attempt to open an autoclave door while the chamber contains any pressure. Doing so may result in severe burns, forceful release of the autoclave door and injury, as well as damage to the unit.

f) log sheets must be available at each autoclave to record the name of the user, time of run, and amount being autoclaved.

4. All floors, laboratory benches, and other surfaces in areas where biohazardous materials are handled must be disinfected upon completion of operations involving plating, pipetting, centrifugation and similar procedures.

5. Floors should be mopped with disinfectant. Avoidance of dry sweeping and dusting will reduce the formation of aerosols. If sweeping is necessary, a push broom and floor sweeping compounds should be used. Waxing and buffing should be done only after mopping.

6. Floor drains must be flooded with water periodically in order to fill traps and prevent the backflow of sewer gases.

Specific Disinfection and Sterilization Methods

Wet Heat

1. The destruction of all forms of microorganisms is most readily accomplished by wet heat or autoclaving (saturated steam under pressure).

   a) Higher pressures give higher internal temperatures.

   b) Appropriate biological indicators should be used in containers or between densely packed materials to determine the effectiveness of the decontamination cycle.

2. Other critical factors which ensure the effectiveness of the autoclaving (besides saturated steam and proper temperature) are the removal of air from the chamber and its contents and adequate exposure time as related to the "soil" load on contaminated items.

   a) Heavily "soiled" items, especially if the "soil" is of proteinaceous nature, should not be flash autoclaved because that "soil" may briefly protect the microorganism from the lethal effects of the wet heat.

   b) Autoclave times are directly proportional to the volume of materials to be autoclaved. Twenty min. at 121^{o}C is adequate for the smallest loads. When volumes in excess of 500 ml are autoclaved, times must be increased. Consult the autoclave manufacturers' handbook for your unit.

   c) It should also be noted that overloading or under loading of an autoclave also reduces the efficiency of decontamination.

   Suggested Temperatures and Exposure Times from NIH Biohazards Guidelines

Laundry -	121^{o}C (250^{o}F), 30 min.
Trash -	121^{o}C (250^{o}F), 1 hr.
Glassware -	121^{o}C (250^{o}F), 1 hr. or 160^{o} (320^{o}F) dry heat, 4 hr.
Liquids -	121^{o}C (250^{o}F), each gallon, 1 hr.
Small Animals -	121^{o}C (250^{o}F), 8 hr.

CAUTION!
Never autoclave hazardous chemicals! Doing so can create hazardous conditions. Very few chemicals are considered acceptable to autoclave. If you have questions about autoclaving chemicals, contact Environmental Health and Safety at extension 3-6260.

Dry heat

The use of dry heat for the disinfection or sterilization of biohazardous materials and contaminated items is less efficient than autoclaving and requires a longer exposure time with higher temperatures.

a) It may be possible to disinfect "soiled" materials by exposing them to 160^{o}C (320^{o}F) for four hours.

b) If items are heat sensitive, a temperature of 120^{o}C (248^{o}F) must be used, and exposure time necessary for disinfection or sterilization is usually greater than 24 hours.

c) The use of biological indicators (Bacillus subtilis spores) is also necessary with dry heat to determine the effectiveness of the sterilization cycle, and to determine the most effective temperature and/or exposure time for sterilization of materials or equipment.

NOTE
Dry heat at high temperatures and for long duration **should** be used to sterilize oils and anhydrous materials such as powders.

Ethylene Oxide

Ethylene oxide (EtO) gas is lethal for all known microorganisms. This is true whether EtO is used undiluted or with CO_2, or other dilutents. Some of the process variables which affect the microbiocidal rate are as follows:

1. Temperature affects the penetration of EtO through microbial cellular components and wrapping and/or packaging materials. The microbiocidal activity of EtO increases with the increase in temperature. Generally, temperatures between 38^{o}C and 54^{o}C (100^{o}F and 130^{o}F) are employed in the EtO sterilization process.

2. Microbiocidal activity is increased as the concentration of EtO is increased, up to about 1,000 micrograms per liter of EtO. For practical sterilization, gas concentrations of 500 to 1,000 micrograms per liter at approximately 49^{o}C to 60^{o}C to (120^{o}F to 140^{o}F) are recommended.

3. Moisture is required for the microbiocidal activity of EtO and appears to be related to the moisture content of the exposed microorganism. This is especially true for the moisture content of the bacterial cell wall. A relative humidity of 30 to 60% is frequently employed in EtO chambers to ensure the proper moisture conditions.

4. The exposure time depends on the above noted variables. Since these variables will not be the same in different commercially available EtO chambers, exposure times recommended by the manufacturers should be followed.

PRECAUTIONS FOR USE OF ETHYLENE OXIDE

1. The use of EtO to sterilize heavily "soiled" items has not been adequately documented. Thus, if "soiled", heat sensitive items are sterilized with EtO, subsequent treatment with a chemical disinfectant is recommended.

All items except those made of glass and metal should be aerated prior to handling or contact with human skin because EtO which has been absorbed by PVC, rubber, etc., can cause burns or skin irritation unless first removed by aeration. The elimination of harmful EtO residues from the most challenging materials (PVC) can be achieved as follows:

- Storage at room temperature for seven days.
- Mechanical aeration at elevated temperature ($60^{o}C$) in an aeration cabinet for eight hours.

2. Mixtures of EtO and air are explosive. However, commercially available mixtures of EtO and CO_2 are not explosive.

3. Always use the manufacturer's recommended exposure time for EtO.

Q. PHARMACEUTICALS/CONTROLLED SUBSTANCES

Regulatory Agency

Controlled substances are chemical products which have the potential for misuse as illegal drugs or as key ingredients in the manufacture of such materials. The United States Department of Justice Drug Enforcement Administration (DEA) regulates the purchase and use of these products for research purposes.

Procedures

1. The Principal Investigator is required to obtain a license through the DEA for the use of controlled substances.

2. At Jefferson, all purchase orders for controlled substances are processed through Supply Chain Management. A DEA form #222 must be filled out for each order and must accompany the purchase request.

3. For the first order, a current copy of the license must be included for filing.

4. Subsequent orders need only include the license number which can be verified against the file copy.

5. Purchase orders received from investigators who do not have a current license on file cannot be filled and will be returned with an explanation.

6. Specific requirements for storage and handling of controlled substances have been established by the DEA. These requirements must be followed by the Principal Investigator who has the license and all lab or other personnel who work with the

substances. This information is contained in the "Physician's Manual", which is available upon request from the DEA. The Principal Investigator must obtain a copy and familiarize himself/herself with its contents at the time he/she applies for the DEA license.

Removal of expired controlled substances must be authorized by the DEA. These substances must be destroyed when their use is no longer necessary and PRIOR to the licensee's leaving the institution.

R. HAZARDOUS (CHEMICAL) MATERIALS

The following definitions have been abstracted from the Code of Federal Regulations, Title 49-Transportation, Parts 100 to 177. Refer to these sections for complete details.

Hazard Class, Definitions, and Associated Symbols

1. Explosive

   Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i.e., with substantial instantaneous release of gas and heat is considered an explosive. Picric acid (in a dry state), sodium azide and ammonium trinitrate are in this class.

2. Combustible Liquid

   Any liquid with a flash point from 100^{o}F to 200^{o}F, except any mixture with one component or more with a flash point at 200^{o}F or higher, that makes up at least 99% of the total volume of the mixture.

3. Corrosive Material

   Any liquid or solid that causes destruction of human skin tissue or a liquid that has a severe corrosion rate on steel, copper, aluminum or other metal used in supporting structures. Strong acids such as hydrochloric, nitric, sulfuric and hydrofluoric are included.

4. Flammable Liquid

   Any liquid with a flash point less than 100^{o}F with the following exceptions: (i) A flammable liquid with a vapor pressure greater than 40 psi at 100^{o}F, (ii) Any mixture with one component or more with a flash point of 100^{o}F or higher that makes up at least 99% of the total volume of the mixture; and (iii) A water-

alcohol solution containing 24% or less alcohol by volume if the remainder of the solution does not meet the definition of a hazardous material.

5. Compressed Gas

Any material or mixture in a container with a pressure exceeding 40 psi at 70^{o}F, or a pressure exceeding 104 psi at 130^{o}F; or any liquid flammable material with a vapor pressure exceeding 40 psi at 100^{o}F.

6. Flammable Gas

Any compressed gas meeting the requirements for lower flammability limit, flammability limit range, flame projection, or flame propagation criteria. Includes but is not limited to diazomethane, methylamines, acetylene, hydrocarbons and hydrogen. Oxygen and nitrous oxide, while not flammable, will support combustion.

7. Nonflammable Gas

Any compressed gas other than a flammable compressed gas. Includes the inert gases (He, Ar, Ne, Kr), and nitrogen.

8. Flammable Solid

Any solid material, other than an explosive, which is liable to cause fires through friction, absorption of moisture, spontaneous chemical changes, retained heat from manufacturing, or processing, or which can be ignited readily and when ignited burns so vigorously and so persistently as to create a serious transportation hazard. Includes pyrophoric compounds such as finely divided metals (calcium, titanium); metal hydrides (lithium aluminum hydride, sodium borohydride); diborane, calcium carbide, and sodium and potassium metals.

9. Organic Peroxide

An organic compound containing the bivalent -0-0- structure and which may be considered a derivative of hydrogen peroxide where one or more of the hydrogen atoms have been replaced by organic radicals. Includes easily peroxidizable compounds like ethers (diethyl, isopropyl, dioxane, tetrahydrofuran). Many of these pure solvents are shipped without peroxide inhibitors.

10. Oxidizer

A substance such as chlorate, permanganate, inorganic peroxide, nitro carbonitrate, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter.

11. Poisonous

Poisonous substances, in solid, liquid or gaseous form, which are known to be toxic to man and pose a hazard to health during transportation; or which in the absence of adequate data on human toxicity, are presumed to be toxic to man.

12. Irritating Material

A liquid or solid substance which upon contact with fire or when exposed to air, gives off dangerous or intensely irritating fumes. Does not include any Class A poisonous material.

13. Infectious Substance (Etiologic Agent)

A viable microorganism or its toxin which causes or may cause severe, disabling or fatal disease in humans or animals.

14. Radioactive Material

Any material or combination of materials, that spontaneously emits ionizing radiation and which has a specific activity greater than 0.002 microcuries per gram.

15. Miscellaneous Hazardous Material

Any material that does not meet the definition of any other hazard class mentioned but may still pose a hazard during transportation of the material.

This class includes:

a) Materials which have an anesthetic, irritating, noxious, toxic, or other similar property and which can cause extreme annoyance or discomfort to passengers and crew in the event of leakage during transportation.

b) Materials (including a solid when wet with water) capable of causing significant damage to a transport vehicle or vessel from leakage during transportation.

c) Materials which have other inherent characteristics not described above but which make them unsuitable for shipment, unless properly identified and prepared for transportation.

16. ORM-D (other regulated materials)

A material such as a consumer commodity which presents a limited hazard during transportation due to its form, quantity, and packaging.

DEPARTMENT OF TRANSPORTATION
REPRESENTATIIVE HAZARD SYMBOLS AND PLACARDS

Flammable Liquids

Introduction

In any fire or explosion occurring in a laboratory at Jefferson, the severity of the fire will depend to a great extent on the amount of flammable liquids in the area and how they are stored. This section establishes maximum amounts of flammable liquids for various laboratories and describes the types of containers to be used for various chemicals.

Definitions of Flammable and Combustible Liquids

Flammable:

Class IA
Flashpoint below 73^{o}F (23^{o}C) and boiling point below 100^{o}F (38^{o}C)

Class IB
Flashpoint below 73^{o}F (23^{o}C) and boiling point at or above 100^{o}F (38^{o}C)

Class IC
Flashpoint at or above 73^{o}F (23^{o}C) and below 100^{o}F (38^{o}C)

Combustible:

Class II
Flashpoint at or above 100^{o}F (38^{o}C) and below 140^{o}F (60^{o}C)

Class III
Flashpoint at or above 140^{o}F (60^{o}C)

Storage

All flammable and combustible liquids not in use in a laboratory must be stored in approved storage cabinets or approved storage rooms. Special storage facilities must be provided for materials which have uniquely hazardous properties such as temperature-sensitivity, water-reactivity, or explosive materials.

Although OSHA and NFPA codes include information about flammable liquid storage cabinets, there are no requirements for venting these cabinets to the atmosphere. If, however, the owner decides to vent the cabinet, there are requirements which must be followed to ensure that venting of the cabinet does not create more problems than it

solves. When the vent caps are removed from the cabinets, flame arrestors must be inserted. Then, metal ducting must be attached to the lower vent while the upper one is left open. The ducting must lead to an explosion proof blower/motor in order to exhaust the fumes to the atmosphere. Exhausting by diffusion is not considered adequate to provide a safe work environment.

The storage of flammable liquids must be kept to a minimum. Generally speaking, no more than 10 gallons of flammable liquids should be stored outside flammable liquid storage cabinets or flammable liquid safety cans. Where provided, all flammable material should be returned to the flammable storage cabinet at the end of the day. Storage cabinets and cans should bear approved labels from UL (Underwriters Laboratories) or FM (Factory Mutual).

Flammable liquid storage in laboratories is regulated by the NFPA and the City of Philadelphia Fire Prevention Code. Evaluation of flammable liquid storage in your laboratory can be made by the Department of Environmental Health and Safety.

Storage of chemicals other than flammable liquids and solids in flammable cabinets must be avoided since many chemicals (i.e. acids) can degrade the metal and ruin the integrity of the cabinet. This can result in the collapse of shelves and mixture of incompatible material resulting in a possible fire or release of toxic gases.

Dispensing

1. Dispensing of flammable or combustible liquids must be carried out under a fume hood or in an approved storage room.

2. All drums containing flammable liquids for dispensing must be vented with approved safety bungs.

3. Only drum pumps or self-closing faucets should be used.

4. All drums and all equipment subject to static accumulation must be grounded.

5. Dispensing should only be into approved containers, and any metal containers must be grounded to the drum.

6. All ignition sources must be eliminated from the area.

7. Good housekeeping standards should be maintained, and if possible, all combustible materials eliminated, particularly where flammable liquids are located.

8. Portable fire extinguishing equipment must be provided such as portable dry chemical, foam, or carbon dioxide units.

9. Do not dispose flammable or combustible liquids into sinks or drains. Call the Department of Environmental Health and Safety at ext. 3-6260 for information about the chemical disposal service available.

Disposal

Department personnel should provide an accurate description of all chemical constituents within the waste container. Unknown chemicals present serious problems for the chemical waste management program. Waste management personnel cannot handle or dispose of unknown chemicals or chemical mixtures in a safe manner; therefore, analysis is required, which is very costly.

Peroxidizable Liquids

Peroxide formation in solvents and reagents has been responsible for many serious explosions in laboratories and, therefore, presents a potential hazard. Under normal storage conditions, some chemicals can form and accumulate peroxides which explode violently when shocked or heated. The following information is, therefore, designed to enable a worker to recognize peroxidizable compounds, to test for peroxides, and to handle them safely.

Recognition

There are essentially 10 major structures that readily form peroxides. As determined from the literature, the first 6 have caused numerous explosions and the last 4 very few.

1. Ethers, acetyls;

2. Olefins with allylic hydrogen, chloro- and fluoro-olefins, terpenes, tetrahydronaphthalene;

3. Dienes, vinyl cetylene;

4. Vinyl monomers including vinyl halides, acrylates, methacrylates, vinyl esters;

5. Alkali metals such as potassium

6. Alkali metal, alkoxides and amines such as sodamine;

7. Paraffinic and allyl aromatic hydrocarbons, particularly those with tertiary hydrogen;

8. Organometallics such as Grignard reagent;

9. Aldehydes, ketones; anhydrous acetaldehyde (will undergo oxidation at 0°C or below; will undergo catalysis under ultraviolet light to form peracetic acid, which may react with more acetaldehyde to give the explosive acetaldehyde monomer acetate);

10. Ureas, amines, and lactams.

The more volatile the peroxidizable compound, the more likely that peroxides can be formed. Pure compounds are more subject to peroxide accumulation. Impurities may inhibit peroxide formation or catalyze their slow decomposition. Peroxide accumulation involves a balance between peroxide formation rate and degradation rate under the environment of a given compound. For example, certain highly reactive compounds such as organometallics accumulate peroxides at low temperatures because the peroxide degradation rate is slowed relative to formation rate. In contrast, less reactive compounds such as hydrocarbons or ethers are usually best kept at low temperature.

Purchase

After making a chemical purchase, laboratory personnel should label all chemicals that are in the following lists with the date of purchase. When possible, commercial solvents should be purchased with peroxide inhibitors incorporated into them.

The chemicals below must be labeled as containing peroxides.

Group 1 (3 months)

Divinyl acetylene
Isopropyl ether
Potassium metal
Sodium azide
Vinylidene chloride

Group 2 (6 months)

Acetal
Cumene
Cyclohexene
Diacetylene
Dicyclopentadiene
Diethyl ether
Dimethyl ether
Dioxane
Ethylene glycol dimethyl ether
Glyme
Methyl acetylene

Group 3 (12 months)

Acrylic acid
Acrylonitrile
Butadiene
Chloroprene
Chlorotrifluoroethylene
Methyl methacrylate
Styrene
Tetrafluoroethylene
Vinyl acetate
Vinyl acetylene
Vinyl chloride
Vinyl pyridine

Methyl isobutyl ketone
Methylcyclopentane
Tetrahydrofuran
Tetrahydronapthalene (Tetralin)
Vinyl ethers

The peroxide hazard from Group 1 is derived solely from storage. Group 2 presents a peroxide hazard upon concentration (evaporation, etc.), and Group 3 is hazardous upon peroxide initiation during polymerization. When stored as a liquid, the peroxide forming potential of the Group 3 chemicals increases and certain of these monomers (especially butadiene, chloroprene and tetrafluorethylene) should then be considered as Group 1 compounds.

Storage

1. All peroxidizable compounds should be stored away from heat and light. Sunlight is an especially good promoter of peroxidation.

2. Peroxidizable liquids should be stored in metal cans if possible. Particular care should be given to ensure good closure of storage containers. Whenever possible, store peroxidizable compounds (except certain inhibited vinylmonomers) under a nitrogen atmosphere.

3. All containers with peroxidizable chemicals should be protected from physical damage and ignition sources.

4. Group 1 materials, those which accumulate peroxides to a hazardous level simply on storage, must be evaluated for peroxide content at least every three months after opening. They should be re-dated if safe or disposed of in an approved manner if the peroxide level is high.

5. Group 2 and Group 3 materials should not be stored for longer than twelve months after opening unless shown by a suitable test not to have accumulated peroxide. Discretion must be used with respect to storage after opening. Should it be desirable to retain Group 2 or 3 materials which give a positive test for peroxide, the material must be treated to remove the peroxide, rebottled, and the label re-dated.

6. Quantities of uninhibited vinyl monomers greater than 500 g. should not be stored for longer than 24 hours. For storage in excess of 24 hours, quantities of vinyl monomers greater than 10 g. should be inhibited with a suitable inhibitor. The name and quantity of the inhibitor should be indicated on the label. Storage of less than 10 g. of an inhibited vinyl monomer for longer than a 24-hour period should be done only with discretion.

7. When handling peroxidizable compounds stored in cylinders, care must be taken to ensure that the cylinders are maintained free of air.

8. All peroxidizable liquids, whether open or not, should never be used or stored beyond the expiration date printed on the container.

Ethyl Ether

Storage and Quantity

A laboratory should never keep more than a total of 3 lb. (1.4 kg) of individually dated containers of ethyl ether on hand. Ether should not be stored near acids or caustics, particularly anhydrous nitric acid. Ether can react slowly with oxygen to form explosive peroxides. The rate of formation depends upon the particular ether and storage conditions. When not in use, ether should be stored in flammable liquid storage cabinets or explosion proof refrigerators.

Required Safe Practices

1. Use the grade of ether designed for the procedure. Do not use anhydrous ether unless the procedure requires it.

2. Lab shelf storage must be in approved safety cans. Newly acquired cans of ether should be dated and kept no longer than 6 months after opening and never beyond the expiration date printed on the container.

3. Lab personnel must wear personal protective equipment (including eye protection).

6. Ether spills can be absorbed with a wet sponge or paper towel. The wet material must be placed in a fume hood for vapor evaporation.

7. When ether is transferred to another container, the new container must be properly labeled. The new container should not be glass.

8. For disposal of large quantities of ether, call the Department of Environmental Health and Safety at ext. 3-6260.

Hazards

Ether has a relatively low toxicity, especially in the context of laboratory use. However, it is extremely flammable with a flashpoint of -45^{o}C.

CO_2, ABC, or BC dry powder fire extinguishers are to be used in areas with ether.

Good general ventilation is required. The Department of Environmental Health and Safety should be contacted to determine adequacy of local ventilation in areas in which ether is used.

Safe Handling of Carcinogens, Mutagens, and Teratogens

General Information

Chemical carcinogens, mutagens, and teratogens are used in many laboratories at Jefferson. In order to protect both the workers and the community from health hazards associated with the use of these substances, each cancer-causing compound must be recognized as a carcinogen and handled with the appropriate precautions.

A wide variety of compounds have been found to be carcinogenic for experimental animals. In some instances, these compounds have been identified as potential human carcinogens. In other cases, the compounds are suspected of being human carcinogens, although definitive scientific evidence does not currently exist. All compounds that cause cancer in any species must be regarded as potentially hazardous to humans.

Several references on carcinogens are available from the Department of Environmental Health and Safety. Several organizations compile lists on carcinogens including the International Agency for Cancer Research (IRAC) Monographs, the National Institute of Occupational Safety and Health (NIOSH), and the National Toxicology Program (NTP) Annual Report on Carcinogens.

When possible, non-carcinogenic substances should be substituted for chemical carcinogens. If substitution is not possible, care must be taken to avoid exposure through inhalation, ingestion, and absorption through the skin.

Below are listed some of the types of chemicals that are known to have carcinogenic, mutagenic, and/or teratogenic potential. The hazard will depend on the specific substance and concentration being used.

Acetamide	2,4-Dichlorophenol	Lithium chloride
Aniline hydrochloride	Diphenylamine	Methyl ethyl ketone
Benzene	Ethidium bromide	Nickel(ous) ammonium sulfate
Benzidine	Ethylene dichloride	Nickel(ous) chloride
Cadmium chloride	Ferric oxide	Nickel(ous) sulfate
Cadmium nitrate	Formaldehyde	Phenol
Carbon tetrachloride	Isoamyl alcohol	1-Propyl alcohol
Chloroform	Isobutyl alcohol	Pyrogallic acid
Chromic acetate	Kerosene	Salicyclamide
Chromic acid	Lauric acid	Sodium chromate
Colchicine	Lead acetate	Sodium dichromate
Dichloromethane	Lead chloride	Tannic acid
1,2-Dichlorobenzene	Lead nitrate	Thioacetamide

Chemical Review and Approval

The Occupational Health and Safety Administration requires special consideration be given to work involving particularly hazardous chemicals. At Jefferson, research involving the use of carcinogens, mutagens and other toxins is reviewed by the Department of Environmental Health and Safety in conjunction with the Laboratory Safety Committee. Review is accomplished through completion of an IBC-14 form from Environmental Health and Safety. This is done in order to ensure that each researcher has adequate protective measures in place to protect against exposure to these materials. A copy of the IBC-14 form can be found in **Appendix D** of this manual. The form, along with supporting documentation, can also be found on the IBC's website at http://www.jefferson.edu/ohr. Choose "Research Biological Safety" from the left hand menu, and then choose "forms."

Chemical Waste Disposal

Most laboratories using chemicals in their activities will produce chemical wastes requiring regulated disposal. At Jefferson, the Department of Environmental Health and Safety has responsibility for the safe and legal management of hazardous chemical wastes. A multifaceted program has been developed to accomplish this goal. The procedures outlined in this section are designed to promote: 1) safe handling of wastes to prevent spills and other accidents, 2) an efficient disposal process for all concerned, and 3) compliance with all applicable regulations governing hazardous wastes.

Regulatory Overview

Jefferson must comply with a variety of environmental legislation. The most comprehensive set of regulations governing hazardous waste management and disposal was promulgated in 1980 by the Environmental Protection Agency (EPA) as the Resource Conservation and Recovery Act (RCRA) and its later amendments. The Pennsylvania Department of Environmental Protection has authorization to administer and enforce these regulations in Pennsylvania. These regulations serve primarily to designate which wastes are hazardous, as well as how they must be handled, stored, disposed or recycled.

Waste Definitions

The RCRA regulations include a list of several hundred chemicals which are specifically designated as hazardous wastes. This list includes most common solvents, many reagents, acids, toxic substances, and other industrial and/or laboratory chemicals. Since such a list could never include all possible hazardous wastes, there are four general characteristics used to define non-listed materials as hazardous wastes. These characteristics are **ignitable, corrosive, toxic, and reactive**. Examples of each of these categories are included. Most chemical wastes generated in a laboratory setting can be considered hazardous in one form or another and should be treated as such. If there is any question regarding the handling of a chemical waste, even if considered non-hazardous, call the Environmental Health Officer in the Department of Environmental Health and Safety for advice and assistance.

Ignitable

This category refers to solvents with a flash point of less than 60^{o}C. Typical ignitable solvents used in labs include alcohols (methanol, isopropanol, etc.), aliphatic hydrocarbons (pentane, hexane), ketones (acetone, MEK), and aromatic compounds such as benzene, toluene, and xylene.

Corrosive

As described in the EPA Regulations, this group of chemicals includes acids of pH less than 2, and bases of pH greater than 12.5. Local regulations prohibit disposal of materials with a pH less than 6 and greater than 9 to the sewer. Small quantities of acids and bases may be neutralized in the laboratory; larger amounts must be collected by Environmental Health and Safety for proper disposal.

Toxic

This is a very broad category which refers to chemicals which may be injurious to human health through inhalation, ingestion, or skin contact. Typical laboratory wastes which are included in the toxic category are metals, stains, and DNA extraction chemicals. Other toxic materials include pesticides and carcinogens.

Reactive

Chemicals in this category are either inherently unstable, or upon contact with other materials react violently or release toxic gases. Typical reactive materials which may be part of a laboratory's waste stream are cyanide compounds, strong oxidizers such as potassium permanganate and perchloric acid, metallic sodium and potassium, picric acid, butyl lithium, old ethers which may have formed peroxides, and explosive salts such as sodium azide. Reactive materials must be treated with extreme caution to protect not only the personnel in the laboratory, but also those who handle and package the material for its disposal process. Because of the considerable cost associated with disposal of reactive wastes, purchase volumes should be minimized and in-house reduction techniques should be explored to render reactives less hazardous prior to entering the disposal route. Laboratories generating a reactive chemical waste stream must have these materials collected regularly to prevent large quantities from accumulating.

Disposal Routes

Chemical waste collected by the Department of Environmental Health and Safety may follow several processing and/or disposal routes. These are explained below to give the reader an understanding of the various methods used to dispose chemical wastes and to explain why specific packaging and labeling procedures are a critical step in the process.

Waste Minimization Strategies

In-house Reduction

If a chemical waste can be neutralized or otherwise rendered nonhazardous in the laboratory, collection by the Department of Environmental Health and Safety may be unnecessary. This is especially desirable if a lab produces small quantities of waste on an infrequent basis. Questions about waste reduction methods for specific materials or requests for additional information may be directed to the Environmental Health Officer.

The neutralized waste, depending upon its physical state and chemical composition, can then be disposed by pouring small amounts down the drain or by exhausting slowly into an operating fume hood.

Heat Recovery/Fuel Blending

A large portion of the chemical waste collected for disposal is solvent waste which can be used for other purposes. In consideration of hazardous waste minimization laws, the Department of Environmental Health and Safety has arranged for recycling of these solvents through heat recovery or fuel blending programs at EPA permitted facilities. Typical solvents used for this program include alcohols, scintillation cocktails

(containing <0.05 microcuries of H3, C14 or decayed to background P32) acetone, acetonitrile, toluene, and xylenes.

Treatment Strategies

Incineration

A significant portion of laboratory waste generated at Jefferson is processed through direct incineration. These materials are burned at temperatures exceeding 2,000° F. Materials which cannot be disposed by this route include solids, metals in solution, and chemicals which have an inadequate heat of combustion to ensure complete destruction. Because of these limitations, it is important that materials not suitable for incineration be placed in separate waste containers so that they may be disposed by another method.

Neutralization/Extraction

The chemical waste program receives some wastes which cannot be discharged into the sewer system even after neutralization due to the presence of various metals and other toxic materials. Such materials typically include sulfuric acid/potassium dichromate solutions for cleaning glassware (Chromerge), and atomic absorption waste. These types of waste materials are typically packaged in a drum with like materials and disposed through facilities where the metal content can be effectively extracted during the disposal processes.

Landfill

If laboratory chemical waste cannot be disposed through the other described treatment methods, it must be properly packaged for disposal at a secure hazardous waste landfill. After collection by the Department of Environmental Health and Safety, containers are packed with a non-reactive absorbent in appropriate shipping containers according to compatibility. Full drums are transported and disposed by an EPA approved waste management firm.

NOTE: Amendments to the RCRA laws continue to narrow the scope of chemicals permissible for land filling in recognition of their potential to contaminate groundwater supplies should the landfill leak.

Sewer Disposal

Very few chemical wastes produced in laboratories are acceptable for discharge to the sanitary sewer system. Even very small quantities of chemicals can have a significant impact when combined with similar discharges from other laboratories. Such practices also fail to teach the importance of environmental responsibility that should be carried by students into the industrial and business world. Therefore, even small quantities of chemical wastes should be disposed of through the Chemical Waste Program unless otherwise indicated by the Department of Environmental Health and Safety.

Specific materials which cannot be put into laboratory drains under any circumstances include:

a. Solids large enough to plug lines

b. Combustible, flammable or explosive wastes

c. Wastes which are toxic or inhibitory to biological waste treatment

d. Large quantities of water insolubles which may settle and plug lines

e. Highly reactive materials (i.e., strong oxidizers such as phosphorous oxychloride)

f. Radioactive materials (unless approved by the Office of Radiation Safety)

g. Carcinogenic agents or suspected carcinogens

h. Corrosive wastes that cannot be neutralized

i. RCRA listed wastes (list available by calling extension 3-6260)

If you have specific questions regarding sewer disposal of a chemical, please call the Department of Environmental Health and Safety's Environmental Health Officer.

Ethidium Bromide Waste

Ethidium bromide(EtBr) is a potent mutagen used as a fluorescent stain for visualizing nucleic acids in life sciences research. Proper management of EtBr waste is important. The following guidelines are offered for various waste streams containing EtBr.

Aqueous Solutions of EtBr

Aqueous solutions containing less than 10 μg/ml EtBr may be disposed to the sanitary sewer. Solutions containing greater than 10 μg/ml EtBr must either be surrendered to the Chemical Waste Program or deactivated using the Lunn and Sansone method before disposal to the sanitary sewer. Solutions can also be filtered using any of the commercially available EtBr filter units. The filtered material must then be placed into the Chemical Waste Program.

Acrylamide and Agarose Gels Containing EtBr

All gels containing EtBr are to be surrendered to the Chemical Waste Program. Appropriate waste containers can be obtained by calling either 3-7352 or 3-6260.

Alcohol Solutions of EtBr

Combined EtBr and alcohol solutions are flammable. Therefore, regardless of the concentration of EtBr, all of this material must be surrendered to the Chemical Waste Program.

Lab ware contaminated with EtBr

Contaminated lab ware includes needles and syringes, test tubes, pipettes, etc. Depending upon the type of waste that you generate, follow the appropriate procedures for those materials using the 10 μg/ml rule previously applied. Those items with less than 10 μg/ml EtBr can essentially be disposed without regard to the EtBr. (i.e. sharps into sharps containers, glass into glass disposal boxes, etc) All lab ware with greater than 10 μg/ml EtBr contamination will need to be decontaminated then disposed accordingly or, if not inactivated, surrendered to the Chemical Waste Program in an acceptable container.

Lead and Mercury Recycling

Mercury and lead are two easily recyclable heavy metal materials. The Department of Environmental Health and Safety has programs in place to process these materials for reuse. Mercury must be adequately contained to prevent leakage. Lead used as radioactive shields (i.e. lead pigs, lead foil and bricks) must first be surveyed for radioactivity according to the procedures set forth by the Office of Radiation Safety. For a copy of these procedures, call extension 5-7813.

Photographic Wastes

Current regulations permit the disposal of photographic chemical wastes generated during developing procedures. However, solutions containing silver from these procedures must be disposed through the chemical waste program if the silver is not recovered through a reclamation unit process. Contact the Environmental Health Officer for collection of these wastes.

Waste Oil

Waste oil from vacuum pumps or engine motor oil cannot be disposed of through the sewer system or placed into the trash. Collection by Environmental Health and Safety places such materials in a process for recycling although they are not classified as hazardous waste. Hazardous wastes should not be mixed with pump oil as this makes the waste ineligible for recycling.

Laboratory Procedures

Planning

Before an experiment or research project begins, some consideration should be given to what types of chemical wastes the process will produce. Segregation of wastes that follow different disposal routes is an important component of an efficient disposal process. Before generation of the waste begins, the laboratory must have proper containers and labels. The laboratory should also have someone designated as the person responsible for coordinating collection of the wastes.

Waste Minimization

Each researcher has a legal responsibility as well as a moral obligation to make every reasonable effort to minimize the hazardous waste volume generated by his/her laboratory. This can be accomplished by several methods such as miniaturization of the experimental process, avoidance of unnecessary experiments, and a change to using biodegradable chemical products or "greener" alternatives. Researchers should also document their waste minimization strategies with the Department of Environmental Health and Safety.

Containers

All chemical waste must be placed in a suitable container prior to collection. The container must be compatible with the contents, structurally sound, non-leaking, and have a tight fitting lid or cap. If the quantity of a chemical waste is more than a few gallons per monthly pickup, it is preferred that 5 gallon containers be used as waste containers. These containers are efficient for storage both in the lab prior to collection and in the waste handling facility. Empty 4 liter solvent/reagent bottles may be reused as waste containers for smaller quantities. Rinsed acid bottles with rubberized coatings are exceptionally good for this purpose. With any waste container, it is important to leave some headspace when accumulating waste to allow for expansion of volatile liquids, particularly if glass containers are used. Solid objects such as stirring rods, boiling chips, syringes, and pipettes must not be disposed of in liquid waste containers. If such materials require disposal as hazardous waste, package them in a separate container.

Laboratories must provide their own suitable containers for chemical waste. Containers must be securely closed before they can be collected for disposal. Submission of containers with lids of Parafilm, aluminum foil, rubber stoppers, or no lid at all will be refused. If waste is accumulated in containers larger than 5 gallons, contact the Environmental Health Officer prior to starting accumulation. Certain large containers, such as side spigot carboys, cannot be used for this purpose. If there are specific container needs for a particular chemical waste, contact the Environmental Health Officer.

Labeling

Complete and accurate labeling of chemical waste containers is absolutely essential. A properly labeled bottle serves several vital purposes. The primary purpose is safety. Personnel who handle dozens of waste containers collected each week must be able to protect themselves by taking precautions which are commensurate with the hazards of the materials being handled. Labeling of waste containers is also important while the material is still in the laboratory. It aids in the proper segregation of different waste types and helps to prevent lab personnel from inadvertently mixing incompatibles together in the same waste container. The third major purpose for a properly labeled container dictates the correct disposal route to be followed after collection. A label which reads "waste solvents" or "organic waste" is not useful. Wastes labeled as such or not labeled at all are refused until sufficient analysis is performed to properly characterize the material. For more information about these labels, contact the Environmental Health Officer at extension 3-7352.

Materials collected for disposal must be prepared as follows:

a. Materials must be identified with labels stating contents, lab contact, and phone number. Labels for waste containers are available from the Department of Environmental Health and Safety.

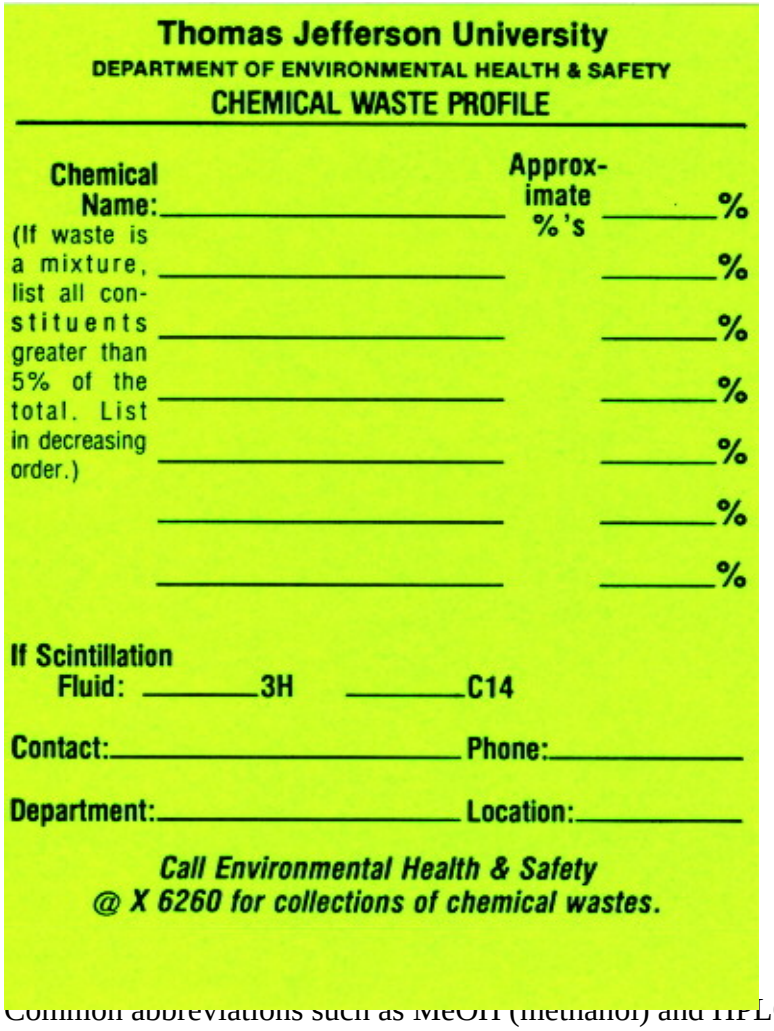
b. Waste solvents which are compatible must be in either 5 gallon poly carboy containers or in glass jugs of not more than one gallon capacity. All containers must have a screw-type closure (no corks or plugs).

c. Miscellaneous laboratory reagents must be in strong, tight containers and must have a positive-type closure in good condition (no corks or plugs).

d. Waste acids cannot be mixed and must also be in glass jugs of not more than one gallon capacity. They too must have a screw-type closure (no corks or plugs).

e. Hazardous materials should be segregated according to classification. See pages 50-53 of this Guide.

Chemical Waste Profile labels are available at no charge. These adhesive labels should be securely affixed to the side of the container. All of the information requested on the waste label must be provided. The description of the waste must include all significant components and their relative percentages in the container. Structural formulas must not be used on waste labels.



Thomas Jefferson University
DEPARTMENT OF ENVIRONMENTAL HEALTH & SAFETY
CHEMICAL WASTE PROFILE

Chemical Name: _____ **Approx-imate %'s** _____%
(If waste is a mixture, list all constituents greater than 5% of the total. List in decreasing order.)
_____ _____%
_____ _____%
_____ _____%
_____ _____%
_____ _____%
_____ _____%

If Scintillation Fluid: _____3H _____C14

Contact: _____ **Phone:** _____

Department: _____ **Location:** _____

Call Environmental Health & Safety @ X 6260 for collections of chemical wastes.

Common abbreviations such as MeOH (methanol) and HPLC Waste (acetic acid, acetonitrile, buffer) may be used, but only if they are easily recognizable. Information written on labels must be written in dark pencil or an indelible lab marker that will not fade or run.

Waste Collection

Once you have properly labeled and prepared your waste for collection, call the Department of Environmental Health and Safety and notify the Environmental Health Officer at extension 3-7352 that a collection is needed. Report the location of the waste and the quantity to be collected. There is no charge for this service.

Laboratory Clean Outs

Most laboratories clean house periodically and discard chemicals and other wastes. The chemical disposal process subsequent to such activities can be greatly simplified by notifying the Environmental Health Officer a week or two prior to starting the clean out. A visit to the laboratory will be arranged to provide suggestions for boxing and containerizing wastes to be disposed. An additional benefit of pre-cleaning notification is that the Environmental Health Officer is made aware of the extra quantity to be received and can plan packaging and disposal activities accordingly.

Laboratory Relocation/Chemical Moves

Occasionally laboratories will relocate to another building on campus. Moving companies contracted by the University will not move chemicals. The transporting of hazardous materials is regulated by the Department of Transportation (DOT). Anyone offering for transport, packaging or transporting hazardous materials must do so under the requirements contained in the Code of Federal Regulations Chapter 49. Individuals/companies who violate these regulations can be held liable and are subject to fines/imprisonment. Therefore, contact the Environmental Health Officer for assistance in moving chemicals to a new location on campus.

S. RADIOACTIVE MATERIALS

The Thomas Jefferson University Radiation Safety Program is designed to promote the safe and constructive use of potentially hazardous ionizing and non-ionizing radiation and to meet regulatory requirements. It is designed for the protection of employees, patients, visitors, students, and the general public. Responsibility for the radiation safety program has been delegated by the President of the University to the University Radiation Safety Committee.

Under the direction of the Radiation Safety Committee, the Office of Radiation Safety and the Radiation Safety Officer (RSO) administer the Radiation Safety Program. The RSO has authority to identify radiation safety program problems; to initiate, recommend, order, or provide corrective actions; and to verify implementation of such actions.

The radiation safety program encompasses the use of all radioisotopes and other sources of ionizing radiation (x-ray machines, etc.), as well as certain sources of non-ionizing radiation such as lasers and microwaves.

The University holds licenses from the U.S. Nuclear Regulatory Commission (NRC) and the Commonwealth of Pennsylvania authorizing the possession and use of radioactive materials. All use of radioactive materials must be in accordance with the terms of these licenses and pertinent federal and state regulations. Similarly, devices which produce ionizing and non-ionizing radiation must be used in accordance with pertinent federal and state regulations.

All uses and users of radioactive materials must be approved in advance by the Radiation Safety Committee. Radiation producing devices must be registered with the Office of Radiation Safety.

Only properly trained personnel are permitted to handle radioactive materials or operate radiation producing machinery. Additionally, persons whose duties bring them into areas where radiation sources are used also require an appropriate amount of training.

The specific radiation safety procedures to be followed by an individual depend highly upon the nature of the radiation source (type, form, strength of source, etc.), the purpose for which it is being used, the area of use, and the nature of the individual's duties.

Specific radiation procedures and precautions have been developed for employees of radioisotope laboratories, Nursing, Radiation Oncology, Nuclear Medicine, Operating Room, Radiology, Ancillary (Environmental Services, Security, etc.), and others. Personnel must not handle radioactive materials or containers, operate radiation producing equipment, enter restricted areas, or perform any duties for which they have not been trained, until or unless they have received proper training and are familiar with the pertinent rules and procedures.

Thomas Jefferson University has established a formal program to assure that procedures are developed and reviewed to ensure that personnel radiation doses are kept As Low As Reasonably Achievable (ALARA). Individuals are expected to adhere to the concept of ALARA by using careful planning and by becoming familiar with safe handling procedures, good radiation safety work habits, and the principles of radiation protection (e.g., utilizing contamination control techniques; minimizing time spent near radiation sources, maximizing distance from radiation sources, and utilizing shielding where applicable).

Radiation safety instructions and procedures, federal and state regulations, and Radioactive Materials License documents are all available from, or for inspection at, the Office of Radiation Safety. Instruction regarding prenatal radiation exposure is also available to pregnant or potentially pregnant female employees. Prenatal radiation instruction is usually handled in a one-to-one session with the RSO, by appointment.

The Radiation Safety Office distributes, collects, and evaluates the readings from radiation dosimeters issued to workers. The RSO conducts investigations of unusual or "high" dosimeter readings. Dosimeter wearers may obtain copies of their radiation exposure history upon written request to the Office of Radiation Safety, at least annually and at termination of employment. Dosimeter wearers are responsible for following proper procedures for the care and use of dosimeters, and for returning them to specified collection points or directly to the Office of Radiation Safety shortly after their designated wear periods.

Radiation Safety personnel provide a number of services to the hospital and university including:

- compliance audits and inspections of radiation and/or radioisotope facilities
- training classes
- bioassays and air monitoring procedures
- disposal of radioactive wastes
- various surveys of radiation sources
- administration of the personnel dosimetry program
- response and investigation of incidents involving radiation
- maintenance of inventories and records

In the event of spills or incidents involving radiation sources or radioactive materials, personnel must contact the Office of Radiation Safety as soon as the situation permits. If the incident involves a radiation source or radioactive materials administered by Radiation Oncology or Nuclear Medicine, either a Radiation Oncology or Nuclear Medicine physicist and/or physician on call must be notified at once. In the event of an injury combined with radioactive contamination of the victim, the Radiation Emergency Medical Plan can be activated by dialing **811**.

The Office of Radiation Safety is located in Room 820, Nevil Building (919 Walnut), and can be reached by telephone at ext. 5-7813. Radiation Safety personnel are available to answer questions about radiation and radiation protection. They will also provide consultation to ensure that radiation sources are used in a safe manner. Whenever the Radiation Safety Office is closed, Radiation Safety personnel can be contacted through the **811** system if urgent assistance is needed.

University Radiation Safety Committee

The University Radiation Safety Committee (RSC) has been established by authorization of the President of the University. It acts as the administrative body responsible for the safe use of all sources of ionizing radiation at Jefferson, including radioisotopes. The use of non-ionizing radiation is also under its purview.

Members of the RSC have been appointed by the President. Membership has been established to meet the requirements of the Nuclear Regulatory Commission, state regulations, and radioactive materials licenses conditions. Membership must include the

Radiation Safety Officer (RSO), a representative of Nursing, an authorized user of each type of use permitted by the license(s), and a representative of management who is not the RSO or an authorized user. The RSC reports to the President of the University, either directly or through his designate(s).

The RSC meets at least quarterly. Additional meetings may be held if problems or conditions warrant the attention of the committee. Minutes of RSC meetings are distributed to RSC members and to the President of the University, and other selected persons at Jefferson.

The RSC has established four subcommittees: the Human Use of Radioisotopes, the Non-Human Use of Radioisotopes, the X-ray, and the Non-ionizing Radiation Subcommittees. A special working group of the Non-ionizing Radiation subcommittee has been established for laser safety.

The RSC (and the RSO) have been provided sufficient authority, organizational freedom, and management prerogative to (1) identify radiation safety problems; (2) initiate, recommend, or provide corrective action; and (3) verify implementation of corrective actions.

The RSC, through the Office of Radiation Safety oversees the entry, use, and disposal of radioactive materials for all University departments.

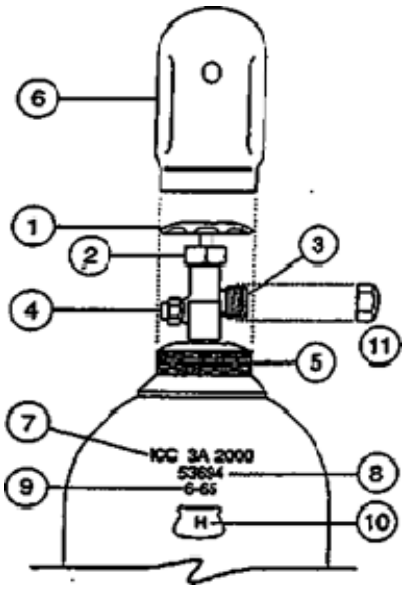
T. COMPRESSED GAS AND COMPRESSED AIR EQUIPMENT

Hazards can result from improper handling of gas cylinders and high pressure equipment, which exist in many University facilities. For example, a leaking cylinder could produce an atmosphere that is toxic, anesthetic, asphyxiating, or explosive; and in the event of a rapid escape, the cylinder becomes a randomly directed missile. The main purpose of properly handling compressed gases is, therefore, to prevent uncontrolled escape of the gas. All handling, storage and utilization of compressed gases must comply with the Compressed Gas Association Standards.

Information

The following information is offered in order to familiarize personnel with cylinder parts and terminology:

CYLINDER DIAGRAM



1. Valve handwheel: used to open and close the cylinder valve. Valves are occasionally not equipped with handwheels and require special wrenches to effect operation.

2. Valve pack nut: contains packing gland and packing around stem. Adjusted only occasionally; usually tightened if leakage is observed around valve stem. Should not be tampered with for diaphragm-type valves.

3. Valve outlet connection: for connection to pressure-and/or flow-regulated equipment. Various types of connections are provided to prevent interchange of equipment for incompatible gases. Usually identified by a CGA (Compressed Gas Association) number, for example, No. 350 for hydrogen service.

4. Safety device: to permit gas to escape if the temperature gets high enough to endanger the cylinder by increased unsafe pressures.

5. Cylinder collar: holds cylinder cap (6) at all times, except when regulating equipment is attached to cylinder valve.

6. Cylinder cap: to protect cylinder valve.

7. This number signifies that the cylinder conforms to Department of Transportation specification DOT-3A governing materials of construction, capacities, and test

procedures; and that the service pressure for which the cylinder is designed is 2,000 pounds per square inch at 70°F.

8. This number is the cylinder serial number.

9. This number indicates the date (month and year; in this case, June l965) of initial hydrostatic testing. Thereafter, hydrostatic pressure tests are performed on cylinders. For most gases this is done every five years to determine their fitness for further use. At this time, new test dates are stamped into the shoulder of the cylinder. Present regulations permit visual tests in lieu of hydrostatic tests for low-pressure cylinders for certain gases free of corrosive agents. Special permits allow for hydrostatic pressure tests at ten-year intervals for cylinders in high-pressure service for certain gases.

10. Original inspector's insignia for conducting hydrostatic and other required tests to approve the cylinder under DOT specifications.

11. Valve outlet cap: protects valve threads from damage and keeps outlet clean; not used universally.

Handling Cylinders

Compressed gas cylinders often contain pressures exceeding 2,000 psi. It is extremely important that care be exercised when handling and storing them. The rules for handling cylinders are relatively simple and straightforward. If they are followed, most serious accidents will be eliminated.

1. All cylinders must be marked as to content. Do not accept cylinders with unidentifiable contents.

2. Unless the pressure regulator is attached, keep the valve protection cap on securely.

3. Cylinders must be secured with straps, chains, ropes, clamps or floor stands at all times to prevent them from toppling. A falling cylinder may shear the valve structure and create an uncontrolled release of high pressure gas. The cylinder can become an uncontrolled missile creating injury, toxic exposure, property damage and possible fatalities.

4. Do not store full and empty cylinders together. Serious "suckback" can occur when an empty cylinder is mistakenly attached to a pressurized system.

5. Group cylinders by type of gas. For example, store oxidizing gases at least 20 feet away from flammable gases.

6. Cylinders must not be stored near sources of heat, ignition, oil, grease, or where they might become part of an electric circuit.

7. Protect from direct rays of sun.

8. Cylinders can be stored in the open but should be protected from the ground beneath to prevent rusting.

9. Bond and ground all cylinders, lines, and equipment used with flammable compressed gases.

10. Limit the storage of corrosive gases to about three months. The cylinder valve stem should be worked frequently to prevent freezing. The valve should be closed when not in use.

11. Cylinders should not be subjected to low temperatures because many steels undergo decreased ductility at low temperatures and could crack.

12. Avoid subsurface storage locations.

13. Before connecting a regulator, the cylinder valve should be opened slightly and closed immediately unless the gas is toxic.

14. Do not try to force a regulator to fit the cylinder. A poor fit probably indicates that the regulator is not intended for use with that particular compressed gas.

15. Never use an adapter fitting.

16. Open the cylinder valve slowly.

17. Never attempt to repair or alter cylinders, valves, or safety relief devices.

18. Do not wipe or touch the valve outlet of an oxygen cylinder valve in such a way that organic residues which might be subsequently ignited by exposure to high oxygen pressure are deposited.

19. DO NOT EMPTY A CYLINDER COMPLETELY. This will prevent a "suckback" and a possible explosive mixture.

20. When discharging gas into liquid, a trap or suitable check valve must be used to prevent liquid from getting into the cylinder or regulator.

21. Do not use copper tubing with acetylene.

22. Avoid rolling or dragging cylinders, even for short distances. Move cylinders only on a hand truck. Use chains to secure them to the hand truck. Do not lift cylinders by the cap.

23. Never drop cylinders or allow them to strike each other sharply.

24. Cylinders can only be charged/filled by the appropriate vendor.

25. Use soapy water or a commercial leak detector to detect gas leaks.

26. If a cylinder develops a leak, the valve packing nut should be tightened. If leakage persists move the cylinder to a location outside where it can vent safely. Avoid ignition sources in the case of a leaking flammable gas. If the gas is flammable or toxic, place an appropriate sign on the cylinder warning against these hazards. Promptly notify the Emergency Response Team by dialing **811.**

Toxic Gases

Cylinders containing toxic gases require special consideration and handling. The same general safety procedures apply; however, extreme care is required when connecting these cylinders to regulators, tubing, manifold systems, or other equipment. Cylinders of toxic gases should never be changed by one person. At least two persons should be involved, preferably with a third party waiting in a safe area. The risk of a leak developing while a cylinder is installed is possible but somewhat unlikely.

Some common examples of gases considered to be extremely toxic are chlorine, arsine, boron trifluoride, bromine, fluoride, phosgene, and phosphine. There are many others which are not listed here. Certain gases may require special equipment to make them safe to use, such as stainless steel tubing or special regulators.

Compressed Air

At Jefferson, compressed air is used for many purposes. The following safety guidelines should be observed:

1. Air lines must be reduced in pressure so as to not exceed 30 psi at the nozzle.

2. Inspect lines regularly.

3. Portable air lines must be stored so they do not hang or extend into machine work areas or traffic patterns. Suitable spring hangers, hose reels, sway bracing, vibration dampers, etc. must be provided.

4. A pressure gauge or a valved connection for a pressure gauge should be located at the outlet of each pressure-reducing valve.

5. Air receivers must be installed so that all drains, hand holes, and manholes therein are easily accessible. Air receivers should be supported with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces. Under no circumstances shall an air receiver be buried underground or located in an inaccessible place. The receiver should be located as close to the compressor or after cooler as possible in order to keep the discharge pipe short.

6. A drain pipe and valve should be installed at the lowest point of every air receiver to provide for the removal of accumulated oil and water. Adequate automatic traps may be installed in addition to drain valves. The receiver should be completely drained frequently and at such intervals as to prevent the accumulation of excessive amounts of liquid in the receiver.

7. Every air receiver should be equipped with a visible pressure gauge with one or more spring-loaded safety valves. The total relieving capacity of the safety valve should be such as to prevent pressure in the receiver from exceeding the maximum allowable working pressure of the receiver by more than 10%.

8. No valve of any type is to be placed between the air receiver and its safety valve or valves.

9. Safety appliances, such as safety valves, indicating devices and controlling devices, are to be constructed, located, and installed so that they cannot be rendered inoperative by any means.

10. All safety valves are to be tested frequently and at regular intervals to determine whether they are in good operating condition.

11. Extreme care should be taken in cleaning the worksite with compressed air. Small particles can be given sufficient velocity to cause severe eye damage. Adequate eye protection such as safety goggles must be worn by all persons engaged in cleaning with compressed air.

Use of compressed air to "blow down" or clean oneself off at any time is prohibited.

U. HAZARD COMMUNICATION

Under Pennsylvania and OSHA regulations, all employees have a right to know the potential toxic effects of the substances to which they are potentially exposed. Employees must receive education and training regarding toxic materials prior to being

assigned to work with them. No employee is to work with a material until he or she has been made familiar with the hazards and is comfortable working with it.

Supply Chain Managment requests Safety Data Sheets (SDSs) from the manufacturer or supplier at the time chemicals are ordered. The manufacturer forwards the SDS to the Department of Environmental Health and Safety, where they are maintained in a reference library. In addition, each laboratory is required to have SDSs available for the hazardous chemicals used in their lab.

These SDSs can also be obtained through MSDSonline®. Employees may access the hospital's intranet webpage and choose the "Emergency/Safety" section in the box titled "Important Links." Simply click on the link "Material Safety Data Sheets," and you will have access to MSDSonline's® database of over two million chemicals. Any questions about the use of this service or about Safety Data Sheets can be directed to the Department of Environmental Health and Safety @ 3-6260.

SDSs contain detailed information about chemicals and are to be reviewed **PRIOR** to working with any hazardous chemical for the first time. Any employee who has a question regarding hazardous material may contact Environmental Health and Safety at 3-6260 for information and assistance.

The OSHA Laboratory Standard

In 1990, the Occupational Safety & Health Administration (OSHA) enacted *"Occupational Exposure to Hazardous Chemicals in Laboratories"*, a regulation known commonly as the "Laboratory Standard." This federal law requires employers to take measures to safeguard employees against exposures to hazardous chemicals in laboratories. If you meet the definition of "laboratory" under the standard, you are covered and must meet the requirements listed below.

OSHA defines ***"laboratory"*** as a facility where the laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are in use on a non-production basis.

REQUIREMENTS:

Employee Exposure Determination

An employee's exposure to a hazardous chemical must be measured if there is reason to believe that exposure levels routinely exceed an action level or permissible exposure limit (PEL).

Chemical Hygiene Plan

The employer must develop and implement a written Chemical Hygiene Plan (CHP). It must cover practices, policies, and procedures for protection against hazardous chemical

exposure and must be available to **ALL** employees and volunteers. *The TJU Guide to Laboratory Safety* is otherwise known as the CHP for Jefferson and is intended to be incorporated into each laboratory's standard operating procedures.

Employee Training and Information

It is the responsibility of each employer to provide its employees with education and training regarding potentially toxic materials. The employer must provide employees with information and training to ensure that they are aware of the hazards of the chemicals present in their work areas. This information must be provided at the time of the employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure potentials. There must be documentation that training was provided. The following items must be addressed as part of the education program:

Employees must be informed of:

- the contents of the Laboratory Standard.
- location and availability of the CHP.
- PELs for hazardous chemicals used in the lab.
- signs and symptoms associated with exposures to hazardous chemicals.
- location and availability of Safety Data Sheets (SDS).

Employees must be trained on:

- methods to detect the presence or release of a hazardous chemical used in the lab.
- physical and health hazards of chemicals in the work area.
- procedures to protect themselves against exposure to hazardous chemicals.
- details of the employer's written CHP.

Medical Consultation and Examination

Employees must be given the opportunity to receive medical attention whenever (1) they exhibit signs or symptoms related to hazardous chemical exposure; (2) monitoring reveals that action levels or PELs are routinely exceeded; or (3) an incident or spill results in the likelihood of an exposure to the employee. Medical evaluation must be provided by the employer at no cost to the employee.

Hazard Identification

Labels on containers of chemicals must not be defaced or removed. SDSs must be made available to laboratory employees. In addition, all bottles within the work place must be labeled as the original bottle is labeled OR with the product identifier and words, pictures, symbols, or combination thereof which provide at least general information regarding the hazards of the chemical, and which, in conjunction with the other

information immediately available to the employee under the hazard communication program, will provide employees with the specific information regarding the physical and health hazards of the hazardous chemical. No abbreviations are permitted. (For example, a bottle may not be labeled just as "Running Buffer;" it also must be labeled with the ingredients of that buffer. Also, using an abbreviation such as "NaOAc" is not permitted; it must be written out as "Sodium Acetate.") SDSs must be made available to laboratory employees.

Respirator Use

When the risk of employee respiratory exposure to potentially hazardous chemical substances exists, attempts to minimize employee exposure should be made through engineering controls, i.e. local exhaust ventilation, chemical fume hood. If such measures are not available or feasible, the use of personnel protective respiratory equipment may be necessary. Before any employee can wear a respirator they **must** contact the Department of Environmental Health and Safety to achieve compliance to OSHA's Respiratory Protection Standard (CFR 1910.134).

Where respirators are necessary to maintain exposure levels below the PEL, the employer must provide them at no cost to the employee.

Record Keeping

Employer medical and exposure monitoring records of employees must be established and maintained.

For additional information regarding compliance with the OSHA Laboratory Standard, contact the Department of Environmental Health and Safety at extension 3-6260.

Safety Data Sheets (SDS)

Federal regulations require chemical manufacturers to provide specific safety information on their chemical products to anyone who purchases them. This information is communicated through a standardized information sheet(s) called a Safety Data Sheet, otherwise known as a SDS. SDSs may vary in appearance depending upon the manufacturer; however, all must contain the following 16 sections:

1. Identification
2. Hazard(s) identification
3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures

6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal Considerations
14. Transport information
15. Regulatory information
16. Other information, including date of preparation or last revision

SDSs are a valuable source of information to laboratory personnel working with hazardous chemicals. SDSs should be reviewed prior to working with the chemical(s) for the first time and periodically as needs dictate. Copies of SDS's can be obtained via the hospital's intranet webpage. The SDS may be kept either on the computer or in a binder within the laboratory, which is immediately accessible to any laboratory personnel.

Note:
Whenever a new chemical is ordered at Thomas Jefferson University, the manufacturer forwards the SDS to the Department of Environmental Health and Safety. All SDSs are kept on file and are readily accessible to anyone who requests safety information on a particular chemical.

Special Environmental Health Programs

Special environmental health programs have been developed to control specific exposures. These programs include (but are not limited to):

Asbestos	Ethylene Oxide (EtO)
Formaldehyde	Indoor Air Quality
Polychlorinated Biphenyls (PCBs)	Underground Storage Tanks

Special Safety Programs

Special safety programs have been developed to control specific exposures. These programs include (but are not limited to):

Centrifuge Safety
Electrical Safety
Ergonomics
Fire Safety
Laser Safety
Office Safety

Note: **For information regarding any of these programs, contact the Department of Environmental Health and Safety.**

V. FUME HOODS AND OTHER CONTAINMENT DEVICES

Introduction

This section has been developed to provide information on the use of fume hoods and other containment devices and the criteria used to verify their performance. Maintenance programs currently in effect include a periodic evaluation of each hood to determine that it can safely remove contaminants away from the operator's breathing zone and from the laboratory. Labels are attached to each hood, verifying the date of the last inspection and identifying the type of use for which the hood was designed. A fume hood should be considered a piece of laboratory equipment that requires proper use, care, and maintenance.

Performance Criteria

All fume hoods will operate at an average face velocity range of 95-125 linear feet per minute (lfm). There is now considerable evidence that higher face velocities (>125 lfm) frequently do more harm than good in capturing and exhausting contaminants. In addition, each of the individual measurement points used to obtain the face velocity average must be no less than 80 lfm and no greater than 130 lfm. Face velocity increases as available cross-sectional area decreases. On some fume hoods, it may be necessary to lower the sash to attain an adequate face velocity. If this is the case when the hood receives its inspection, a label will be attached indicating the point at which the sash must be set. Under no circumstances will a fume hood be approved for use if the minimum allowable average face velocity (95 lfm) cannot be achieved at a sash height of 12 inches or greater. If the sash must be set at a point less than 12 inches from fully closed to achieve 95 lfm, the hood is considered nonfunctional and is not to be used until repairs have been made.

Fume hoods must be annually inspected and certified to ensure proper operation. To make arrangements for an inspection contact ENV Services at the number on the sticker. Fume hoods having passed inspection will have a certification label affixed at the optimal sash level for that hood. Fume hoods which fail an inspection will be placed “OUT OF SERVICE” and cannot be used until the necessary repairs are completed.

If your hood does not have a valid inspection sticker (within 1 year), call the Department of Environmental Health and Safety (extension 3-6260) immediately.

NOTE: Whenever a chemical fume hood has been repaired or moved it must be re- inspected prior to its use.

New Installations

Any modification which will affect laboratory ventilation must be reviewed and approved by the Department of Environmental Health and Safety prior to its implementation. Ideally, this type of communication should begin at the initial design phase. This review process serves several important purposes. It protects present and future lab users from an improper installation or inadequate equipment. It also acts to identify problems in the design which are much less expensive to erase and redesign than to tear down and rebuild after the project has been completed. All new installations should be checked for safety prior to use.

TYPES

The following list describes the various types of fume hoods according to their primary function. Separate classes of hoods based solely on face velocities have been eliminated since all hoods should operate in the 95-125 lfm range.

Low Hazard

A low hazard fume hood does not meet one or more of the basic requirements for a general use fume hood and should only be used for low hazard materials. Hoods in this category are NOT considered adequate for permanent laboratory ventilation control and should be repaired or upgraded as soon as possible.

General Use

A general use fume hood can be used for most common laboratory chemicals and situations. Personnel using materials of high toxicity or conducting volatile reactions should contact the Department of Environmental Health and Safety for assistance in verifying safe hood performance.

Radioactive

A radioactive fume hood can be used as a general use hood. However, it often has special modifications that allow it to be used for radioactive materials. This type of fume hood may require special procedures depending on the type of radioactive material used. Duct velocities may need to be greater due to regulatory requirements for dilution of radioactive gases. In-duct filters and interconnections with other hoods are prohibited for hoods in which certain levels of volatile radiogases are generated. Any work in which radioactive gases may be generated must be reviewed by the Office of Radiation Safety.

Carcinogen

A carcinogenic agent fume hood is a general use fume hood which has been specially equipped with a filtering system to capture and remove carcinogens from the exhausted air stream.

Glove Boxes

Glove boxes are totally enclosed containment devices mostly used for work with carcinogenic materials. It is ducted to the outside usually via flexible duct to the laboratory's main fume hood exhaust.

Ventilated Enclosures and Ductless Hoods

The least desirable containment device is the ventilated enclosure or ductless fume hood. These are sometimes chosen as a lower cost approach to an actual fume hood, however, the Department of Environmental Health and Safety seldom approves their use because many contain carbon filter cartridges which the user must replace. Depending upon frequency of use and volumes of chemicals used, the filters can load sooner than the user changes them. There is no indicator that the carbon is "saturated" except for the smell of the chemical which in certain instances already indicates an overexposure. In addition, the exhausted air dumps back into the room and potentially creates unnecessary exposure situations. If you are considering a ductless fume hood, contact the Department of Environmental Health and Safety to determine whether one is applicable for your type of work.

Use of Fume Hoods

Properly ventilated fume hoods must be installed in every laboratory handling chemicals to provide a mechanism for removing toxic and flammable vapors and gases. Hoods must be located away from heavy traffic aisles, exit ways, doorways, and supply air diffusers. Fume hoods constructed by laboratory personnel are prohibited.

Laboratory fume hoods should not be used as storage areas for chemicals and other laboratory items. Doing so restricts the even flow of air across the work area and creates the opportunity for obstructive airflow or turbulence. This reduces the hood efficiency and may create "pockets" or "eddies" where chemicals can escape the confines of the hood. If this occurs, there is the possibility for unnecessary chemical exposures to those working at the hood and within the laboratory.

If materials or equipment must remain in a hood, it is helpful to elevate them on racks which will allow air to pass unobstructed into the lower exhaust slot of the hood. This will reduce turbulence and potential exposures.

Incompatible chemicals should never be placed in the same hood. Appropriate goggles and a fully fastened lab coat or safety apron must be worn any time work is being performed in the hood with flammable, toxic, or corrosive chemicals. Work should be done at least six inches into the hood. This practice aids in efficient capture and exhaust of contaminants.

Biological Safety Cabinets

Information about the use of biological safety and laminar flow cabinets is included in Section P (Biological Safety) of this manual.

W. ELECTRICAL SAFETY

Introduction

Many types of electrical equipment are used in the laboratory; some of these are high voltage and used in the presence of water based solutions. The principal hazards of electricity are electrical shock, burns, and fires. Although these hazards are widely recognized and easily avoided, electrical accidents still occur. It is therefore prudent for each laboratory worker to exercise proper electrical safety precautions as well as to familiarize themselves with potential electrical hazards present in his/her laboratory. Never touch electrically charged devices with wet hands. Laboratory workers should also remove all conductive jewelry on or near the hands such as rings, bracelets, watches and loose fitting necklaces which may dangle from the neck and come into contact with electrical sources

Repairs and Alterations

Under no circumstance is electrical work to be performed except by employees of the Department of Facilities Services. Your request should be submitted to the department. Emergency repairs can be reported by calling extension 5-6846.

Applicable Codes

The requirements contained in the National Electrical Code apply to all electrical equipment, installations, and uses at Jefferson. However, particular attention should be given to the electrical precautions listed below:

All electrical equipment should bear the label of a nationally recognized testing laboratory such as Underwriter's Laboratories (UL) or Factory Manual Engineering Corporation (FM).

Purchase of new equipment must specify three-wire power cords or double insulation.

Do not use defective electrical equipment. Check frequently for defective wiring, frayed cords, and faulty plugs and switches.

Notify Facilities Services of overloaded circuits in order to replace fuses and reset circuit breakers. Redistribution or reduction of the electrical load on that circuit may then be required. Report all cases of electrical shock, however minor, to your supervisor who will place an order for repairs. The equipment then needs to be temporarily tagged, "DO

NOT START", indicating the problem and name of the person in charge. If there will be a delay in repair of the equipment, the switch in the system should be locked out.

The only multiple outlet adapters allowed are those that have fuses and internal circuit breakers. Rearranging equipment or installing additional outlets is always preferred over these devices, however.

Grounding

All existing electrical equipment must be modified to three-wire power cords with a grounding type plug or have a designation of double insulation.

All electric extension cords to portable power tools should be standard heavy duty three-wire cord with a grounding type plug.

Two prong adapters are prohibited. If one is needed, Facilities Services must be called to assess the need and/or install the proper receptacle.

Hot plates, coffee pots, and other special heating appliances should be placed on noncombustible surfaces, be properly grounded, and should never be left unattended. These items must be unplugged after each use. In addition, the units are required to have automatic thermal fuse cutouts.

Electrical Cords

Extension cords must not be used except in the most temporary situations. Do not roll wheeled equipment over electrical cords. Do not run cords under rugs or across areas where there is a possibility they may be stepped on or tripped over.

Explosive Atmospheres

Use only approved power tools in explosive atmospheres. Storage of flammable liquids in refrigerators is not allowed unless the refrigerator is specially designed, wired and labeled as being safe for flammable liquid storage. Flammable storage near refrigerators is allowed only if the refrigerator is explosion proof.

Miscellaneous

Do not handle electrical equipment while standing on a wet surface. Metal ladders should never be used around electrical circuits or in places where they might come into contact with electricity. All power machines shall have electrical control switches in such a location as to make it possible for the operator to cut off the power without leaving his/her position or reaching across the point of operation.

X. ANIMAL CARE AND USE

The use of laboratory animals in life sciences research is not only important but a necessity in many instances. Valuable advances in medical science have been achieved from the use of laboratory animals as research models.

As an employee conducting research involving the use of laboratory animals, you have an obligation to provide the highest level of humane care and use of the animal(s). In addition to this, you must practice appropriate personal safety and hygiene techniques to guard against bites, scratches and aerosols which may present an opportunity for zoonotic infection to yourself or other individuals. Proper disposal of all animal carcasses, tissue and blood contaminated items is an important step in providing personal protection as well as regulatory compliance.

An Occupational Health and Safety Program is offered to all employees associated with the animal care and research programs. The program varies according to the type of animal exposure and level of risk and is administered by the Institutional Animal Care and Use Committee (IACUC).

The Office of Animal Resources conducts periodic orientation sessions for new employees. This training covers many facets of animal handling including restraint techniques, personal hygiene, animal husbandry and zoonosis to mention a few. For more information on training sessions or laboratory animal safety, contact Laboratory Animal Services at extension 3-6167 or 3-5885.

Institutional Animal Care and Use Committee

The Institutional Animal Care and Use Committee has the legal and institutional authority in overseeing the animal care and use program. This committee reports directly to the Vice President of Research. All animal research must be reviewed and approved by the Committee prior to being conducted. Review by other committees such as the Institutional Biosafety Committee and/or the Laboratory Safety Committee will occur whenever animal research involves the use of other hazardous materials such as pathogens or specific chemicals and toxins. Final approval of the research is awarded when all committees have reviewed and approved the protocol. Any concern about the conduct of research may be directed to any member of the committee or to the University Veterinarian for action.

APPENDIX A

SELF INSPECTION FORM FOR LABORATORY SAFETY

Environmental Health and Safety/Research Biosafety Office Laboratory Inspection Form

Building: **Room**: **PI**: **Phone#** **ER Contact**:
Inspector: **Date**: **Dept**: **BSL**:

__ _ Research Lab ___ Clinical Lab _ _ rDNA __ Pathogens	Met	Not Met	N/A	NOTES
100: Hazard Communication				
101. Correct signage on all entrances to the laboratory				
102. Chemical bottles, solutions and containers clearly and properly identified and labeled with ***NO*** abbreviations				
103. MSDS's are on file and readily accessible				
104. Equipment used for biohazardous materials is labeled				
105. Chemical inventory is current and present in lab ***AND*** on file with EHS				
200: Training				
201. All employees attended safety training within the past year				
202. Employees are trained for shipping hazardous material				
300: Laboratory Equipment				
301. Designated hand washing sink is available and labeled as such				
302. Safety shower accessible and unobstructed				
303. Eye wash available, tested weekly and documented				
304. Chemical fume hood is certified/working properly/clutter free				
305. BSC certified/working properly/clutter free				
306. HEPA filter in vacuum line if using infectious materials				
307. Hoses for Bunsen burner in good condition				

	Met	Not Met	N/A	NOTES
400:Personal Protective Equipment				
401. Gloves available and worn during procedures				
402. Protective clothing available and worn during procedures (lab coat, apron, etc.)				
403. Eye protection available and worn during procedures				
500: Chemical Storage				
501. Flammable liquids not stored in conventional refrigerators				
502. Flammable liquids in volumes greater than 10 gallons stored in flammable cabinet				
503. Incompatible chemicals segregated (no water reactive stored under sink, etc.)				
504. Peroxide forming chemicals are dated upon receipt and disposed of properly				
505. Ether and other highly flammable liquids are stored away from sources of light, heat and direct sunlight				
506. Outdated, expired or unknown chemical properly disposed of				
507. All chemical containers are capped and sealed when not in active use (no funnels left in containers for example)				
508. Hazardous chemicals are not stored above eye level, on top of refrigerators, or on the floor				
600: Hazardous Waste				
601. Waste containers properly sealed and labeled				
602. Secondary containment provided for liquid waste				
603. Waste is separated by hazard class				
604. Waste accumulated for no longer than one year				
700. Housekeeping				
701. Food or beverage is NOT consumed in the lab				
702. Lab is neat, clean, and free of clutter, i.e., no slipping/tripping/falling hazards				
703. Exits and means of egress unlocked and unobstructed				
800. Emergency Preparedness				
801. Chemical spill kit available: absorbent materials, materials to neutralize small acid and alkali spills				
802. Employees know proper procedure for reporting chemical spills				

	Met	Not Met	N/A	NOTES
803. Fire extinguishers accessible and inspected				
804. Emergency phone numbers posted and clearly visible				
900. Compressed Gases				
901. Cylinders capped when not in use				
902. Empty cylinders promptly removed from lab				
903. Old cylinders (lecture bottles) removed from lab				
904. Cylinders properly secured				
905. Cylinders labels clear and legible				
906. Proper segregation of full and empty cylinders				
907. Portable liquid nitrogen tanks are properly labeled, stored and vented				
908. Cylinders stored away from all heat sources such as flames, radiant heat, or burners.				
1000. Biological Safety				
1001. Infectious waste properly disposed of and labeled				
1002. Sharps container available				
1003. Universal precautions practiced				
1004. Written decontamination procedure for biohazard spill				
1005. Material for biohazard spill readily available (bleach)				
1100. Other				
1101. Copy of Chemical Hygiene Plan on file				
1102. Material at least 18” from ceiling				

APPENDIX B

EMERGENCY ASSISTANCE LIST

What to do in the event of a fire. Follow the acronym RACE.

RESCUE. Remove persons from the immediate area of danger.

ALARM. **Call ext. 811**
to report **CODE RED**. Give location. Pull nearest fire alarm box as you leave the floor. (Pull boxes are located near the entrance to a fire exit stairwell.)

CONFINE. Close doors.

EVACUATE. Follow the building evacuation procedures

EXTINGUISH. If the fire is in its incipient stage and you have been trained in the use of an extinguisher, extinguish the fire, but only after an alarm has been activated and you feel comfortable doing so.

NEVER USE ELEVATORS OR ESCALATORS DURING A FIRE.

OTHER EMERGENCIES

	WEEKDAYS 9AM-5PM	**OTHER HRS**
BIOHAZARD SPILL	**811**	**811**
BUILDING PROBLEMS *(ELECTRICAL, PLUMBING, VENTILATION, TEMPERATURE REGULATION)*	5-6846	5-6846
BURNING OR CHEMICAL ODOR	5-6846	5-6846
CHEMICAL OR CHEMOTHERAPY SPILL	**811**	**811**
ELEVATOR PROBLEMS	5-6846	5-6846
EQUIPMENT PROBLEMS	5-8655	5-6060
MEDICAL EMERGENCY	**811**	**811**
RADIOACTIVE MATERIAL SPILL	5-7813	**811**
SECURITY	5-8888	5-8888

INFORMATION, REQUESTS, SAFETY CONCERNS, REPORTING UNSAFE CONDITIONS

	CALL
BIOSAFETY	3-7422
DISPOSAL OF BIOLOGICAL WASTE	3-6260
CHEMICAL SAFETY	3-6260
DISPOSAL OF HAZARDOUS CHEMICAL WASTE	3-7352
FIRE SAFETY	3-7153
GENERAL SAFETY	3-6260
ACCIDENT REPORTING HOTLINE	5-7233
ACCIDENT REPORTING *(Hospital employees)*	1-888-476-2669
INFECTION CONTROL (HOSPITAL)	5-7186
RADIATION SAFETY	5-7813
DISPOSAL OF RADIOACTIVE WASTE	5-7813

APPENDIX C

Procedures for Laboratory Sharps Disposal

The Pennsylvania Department of Environmental Protection regulates the disposal of Regulated Medical Waste www.pacode.com which includes sharps used in the lab. Used sharps pose a safety hazard to Custodians and Waste Haulers and therefore must be segregated and packaged properly.

The following information is provided to assist you in this matter:

Definitions

Sharp: any device/item having corners, edges, or projections capable of cutting or piercing the skin.

Used Infectious Waste Sharps: (Pennsylvania Department of Environmental Protection definition): Sharps, including hypodermic needles, syringes, (with or without the attached needle), pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, culture dishes, suture needles, slides, cover slips and other broken or unbroken glass or plasticware that have been in contact with infectious agents or that have been used in animal or human patient care or treatment, at medical, research or industrial laboratories.

Infectious Waste Sharps Containers: Containers that are non-breakable, leakproof, impervious to moisture, rigid, tightly lidded (once closed cannot be opened), puncture resistant, red in color and marked with the universal biohazard symbol.

Procedures

1. Custodial Services will provide the lab with one or more of the 18 gallon sharps containers. They are not to be overfilled and must be tightly sealed prior to disposal. Once sealed they do not have to be placed into a box, they will be removed as is.
2. The labs ae responsible for the purchase of the smaller sharps containers. Again, they are not to be overfilled and must be tightly sealed prior to disposal. Once sealed, these containers may be placed in the black biohazard trash containers.
3. The following items **(whether contaminated with infectious materials or not)** are considered sharps and must be disposed in infectious waste sharps containers.

    - Needles (including suture needles)
    - Syringes (with or without needles)
    - Needles from vacutainers
    - Needles with attached tubing
    - ALL blades (razors, scalpels, etc)
    - Pasteur pipettes
    - Glass slides or cover slips

- serological pipettes

APPENDIX D

FORM IBC-14: Application for Research using Particularly Hazardous /Toxic Materials

IACUC PROTOCOL NUMBER:		
(EHS use only)	**Approved by:**	**Date:**

Please complete sections 1-15 answering all questions and provide all requested information before ordering the compound and beginning work. The Department of Environmental Health and Safety (3-6260) can provide you with information and assistance i needed. Use one form per chemical or toxin. Please send the original completed and signed form along with a copy of MSDS to the Department of Environmental Health and Safety Edison Building Room 1630 ATTN: Stephen Baker.

Please note: ***Every laboratory that uses chemicals must also have a Chemical Hygiene Plan (The Thomas Jefferson University "Guide to Laboratory Safety" serves as your Chemical Hygiene Plan. (for copies contac Department of Environmental Health and Safety 3-6260) Place a copy of this completed form in your laboratory's Chemical Hygiene Plan.***

1. Contact Information		
Principal Investigator:		
Person Completing This Form:	Title:	
Animal Protocol Title:		N/A: ☐
Building:	Room:	
Telephone Number:		
Emergency Contact Number:		
Email Address:		

2. Chemical/Toxin Information

Identify Chemical **Requiring Review** which will be in this protocol.

Chemical Name (no formulas or abbreviations)	Vendor	CAS# (can be found on MSDS)	MSDS on Hand?

			☐
Amount (weight or volume) on hand at any given time:	Amount used in single experiment:		

3. Where will material be stored

☐ Flammable Storage Cabinet ☐ Refrigerator/Freezer ☐ Locked Cabinet ☐ Other

4. Preparation of the dose

What will be combined with the chemical to make the dose (food, water, alcohol, etc.)?		
Will the dose be prepared in a chemical fume hood?	☐ Yes	☐ No
Will this chemical be used in animal subjects?	☐ Yes	☐ No (proceed to section 7)

5. Administration of experimental chemical (injection, topical application, etc.)

Dose(s):	Route of administration:
Frequency of dose:	How many days will the chemical be administered?

6. Amount of agent/toxin excreted/secreted in (if known): (check all that apply)

Urine	Significant ☐	Trace ☐	Undetectable ☐	Unknown ☐	☐ None will be released
Feces	Significant ☐	Trace ☐	Undetectable ☐	Unknown ☐	☐ None will be released
Expired air	Significant ☐	Trace ☐	Undetectable ☐	Unknown ☐	☐ None will be released
Skin	Significant ☐	Trace ☐	Undetectable ☐	Unknown ☐	☐ None will be released

7. Education/Training

What type of education program do you plan to use to inform laboratory workers of the hazards associated with the use of this chemical?

Describe:	

List the names of employees who will be working with this chemical and check all that apply:

Employee Name	**Lab Safety Training Attended and/or Healthstream Training is up to date.**	**Aware of the Hazards of this Chemical**	**Aware of the Safe Work P□actices Needed while Using This Chemical**
	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

8. Hazard Communication

Describe how you will communicate the hazards of this chemical to anyone working in the area or anyone who may have access to the area such as LAS, Facilities Services, or Custodial Services employees? i.e. signage on outside door, labeling of cages, etc.	

9. Personal Protective Equipment (PPE)

PPE needed for personnel who will be working with this chemical (check all that apply):

☐ Gloves	☐ Shoe Covers	☐ Gown	☐ Mask	☐ Safety Goggles	☐ Respirator *	☐ Other:

What type Glove will be worn. (Latex is not recommended for all chemical hazards.)

For help in determining best glove type refer to Appendix G or contact EH&S

PPE needed for **animal care staff** attending the exposed animals (check all that apply):

☐ Gloves	☐ Shoe Covers	☐ Gown	☐ Mask	☐ Safety Goggles	☐ Respirator *	☐ Other:

What type Glove will be worn. (Latex is not recommended for all chemical hazards.)

*** Please note: In order to wear a respirator the person must be fit-tested and trained. Contact the Department of Environmental Health and Safety to schedule fit-testing and training 3-6260.**

10. Exposure Symptoms

Will chronic and/or acute exposure produce any symptoms or signs, which would alert you to inadequate exposure protection? Are there additional signs (for example: odor, color, powder, etc. which would alert you to any break in technique and subsequent exposure?

Describe any signs for acute exposure :	
Describe any signs for chronic exposure :	

11. Employee Accident/Documentation

Describe the procedures to be followed if an **accidental exposure** to this chemical occurs to personnel (e.g., researchers, animal care staff).

Immediate action:	
Where to take for medical attention:	**During normal working hours staff members will seek medical attention at University Health Services located at 833 Chestnut Street, Suite 211.** **If medical attention is needed after hours staff and students will seek treatment at the TJUH Emergency Department located in the Main Building at the corner of 10th and Sansom St.**
Employee Accident Report:	**Employee will immediately report any work-related injury or illness to his/her supervisor. Employee's supervisor will complete an "Employee Accident Report" form #0155-10 and submit a copy to the Department of Environmental Health and Safety. Additionally employee's supervisor will call the Accident Reporting Information Hotline 215-955-SAFE (7233) to report the accident.**

12. Emergency Preparedness/Procedures

Describe the procedures to be followed if a **spill** of the chemical occurs.

Is a hazardous materials spill kit available:	☐ Yes ☐ No
Is a first aid kit on hand:	☐ Yes ☐ No
Are the proper PPE materials needed to clean up small spills available, i.e., gloves, lab coat, goggles, foot covers, etc.	☐ Yes ☐ No
Is safety shower available and accessible? ☐ Yes ☐ No	Is eye wash available and accessible? ☐ Yes ☐ No
What should be done with contaminated clean-up materials:	**All materials and debris used in cleaning up spill will be collected and disposed of as hazardous waste.**
What should be done if spill is too large to clean-up:	**Evacuate the area. Alert others in the immediate area of the danger. Call 811 and provide the name of chemical spilled, amount and report any injuries that may have occurred. If flammable materials involved shut off any ignition sources, i.e. Bunsen burners. Wait in a safe area near by until Emergency Response Team arrives.**

13. Decontamination Procedures

Describe the procedures for decontaminating surfaces contaminated with the chemical(s) including counters, cages, etc.:	

14. Disposal of Contaminated Items and Hazardous Waste

Describe the procedures for disposing of carcasses, bedding and other contaminated items.

Carcasses:	
Bedding:	
Other items:	
Describe the procedures for disposing of any remaining material:	

15. Additional Precautions/Procedures

Describe any additional precautions or procedures you feel necessary for working with this chemical/toxin:	

*****Once submitted your application will be reviewed by the Laboratory Safety Committee. Work with this chemical/toxin may not begin until you receive written approval from the committee.**

Signatures (required):

Principal Investigator **Department Chairman** **Chemical Hygiene Officer**

APPENDIX E

EPA List of Hazardous Wastes

EPA Hazardous Waste #	Chemical abstracts #	Substance
P023	107-20-0	Acetaldehyde, chloro-
P002	591–08–2	Acetamide, N-(aminothioxomethyl)-
P057	640–19–7	Acetamide, 2-fluoro-
P058	62–74–8	Acetic acid, fluoro-, sodium salt
P002	591–08–2	1-Acetyl-2-thiourea
P003	107–02–8	Acrolein
P070	116–06–3	Aldicarb
P203	1646–88–4	Aldicarb sulfone.
P004	309–00–2	Aldrin
P005	107–18–6	Allyl alcohol
P006	20859–73–8	Aluminum phosphide (R,T)
P007	2763–96–4	5-(Aminomethyl)-3-isoxazolol
P008	504–24–5	4-Aminopyridine
P009	131–74–8	Ammonium picrate (R)
P119	7803–55–6	Ammonium vanadate
P099	506–61–6	Argentate(1-), bis(cyano-C)-, potassium
P010	7778–39–4	Arsenic acid H_3AsO_4
P012	1327–53–3	Arsenic oxide As_2O_3
P011	1303–28–2	Arsenic oxide As_2O_5
P011	1303–28–2	Arsenic pentoxide
P012	1327–53–3	Arsenic trioxide
P038	692–42–2	Arsine, diethyl-
P036	696–28–6	Arsonous dichloride, phenyl-
P054	151–56–4	Aziridine
P067	75–55–8	Aziridine, 2-methyl-
P013	542–62–1	Barium cyanide
P024	106–47–8	Benzenamine, 4-chloro-
P077	100–01–6	Benzenamine, 4-nitro-
P028	100–44–7	Benzene, (chloromethyl)-
P042	51–43–4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-
P046	122–09–8	Benzeneethanamine, alpha,alpha-dimethyl-
P014	108–98–5	Benzenethiol
P127	1563–66–2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.

P188	57–64–7	Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1)
P001	81–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P028	100–44–7	Benzyl chloride
P015	7440–41–7	Beryllium powder
P017	598–31–2	Bromoacetone
P018	357–57–3	Brucine
P045	39196–18–4	2-Butanone, 3,3-dimethyl-1-(methylthio)-O-[methylamino)carbonyl]oxime
P021	592–01–8	Calcium cyanide
P021	592–01–8	Calcium cyanide $Ca(CN)_2$
P189	55285–14–8	Carbamic acid, [(dibutylamino)- thio]methyl-, 2,3-dihydro-2,2-dimethyl- 7-benzofuranyl ester.
P191	644–64–4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]- 5-methyl-1H- pyrazol-3-yl ester.
P192	119–38–0	Carbamic acid, dimethyl-, 3-methyl-1- (1-methylethyl)-1H- pyrazol-5-yl ester.
P190	1129–41–5	Carbamic acid, methyl-, 3-methylphenyl ester.
P127	1563–66–2	Carbofuran.
P022	75–15–0	Carbon disulfide
P095	75–44–5	Carbonic dichloride
P189	55285–14–8	Carbosulfan.
P023	107–20–0	Chloroacetaldehyde
P024	106–47–8	p-Chloroaniline
P026	5344–82–1	1-(o-Chlorophenyl)thiourea
P027	542–76–7	3-Chloropropionitrile
P029	544–92–3	Copper cyanide
P029	544–92–3	Copper cyanide Cu(CN)
P202	64–00–6	m-Cumenyl methylcarbamate.
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460–19–5	Cyanogen
P033	506–77–4	Cyanogen chloride
P033	506–77–4	Cyanogen chloride (CN)Cl
P034	131–89–5	2-Cyclohexyl-4,6-dinitrophenol
P016	542–88–1	Dichloromethyl ether
P036	696–28–6	Dichlorophenylarsine

P037	60–57–1	Dieldrin
P038	692–42–2	Diethylarsine
P041	311–45–5	Diethyl-p-nitrophenyl phosphate
P040	297–97–2	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	55–91–4	Diisopropylfluorophosphate (DFP)
P004	309–00–2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a,-hexahydro-,(1alpha,4alpha,4abeta,5alpha,8beta,8abeta)-
P060	465–73–6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a-hexahydro-,(1alpha,4alpha,4abeta,5alpha,8beta,8abeta)-
P037	60–57–1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,(1aalpha,2beta,2aalpha,3beta,6beta,6aalpha ,7beta,7aalpha)-
P051	72–20–8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-(1aalpha,2beta,2abeta,3alpha,6alpha,6abeta, 7beta,7aalpha)-& metabolites
P044	60–51–5	Dimethoate
P046	122–09–8	alpha,alpha-Dimethylphenethylamine
P191	644–64–4	Dimetilan.
P047	534–52–1	4,6-Dinitro-o-cresol, & salts
P048	51–28–5	2,4-Dinitrophenol
P020	88–85–7	Dinoseb
P085	152–16–9	Diphosphoramide, octamethyl-
P111	107–49–3	Diphosphoric acid, tetraethyl ester
P039	298–04–4	Disulfoton
P049	541–53–7	Dithiobiuret
P185	26419–73–8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O- [(methylamino)- carbonyl]oxime
P050	115–29–7	Endosulfan
P088	145–73–3	Endothall
P051	72–20–8	Endrin
P051	72–20–8	Endrin, & metabolites
P042	51–43–4	Epinephrine
P031	460–19–5	Ethanedinitrile

P194	23135–22–0	Ethanimidothioc acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester.
P066	16752–77–5	Ethanimidothioic acid,N-[[(methylamino)carbonyl]oxy]-, methyl ester
P101	107–12–0	Ethyl cyanide
P054	151–56–4	Ethyleneimine
P097	52–85–7	Famphur
P056	7782–41–4	Fluorine
P057	640–19–7	Fluoroacetamide
P058	62–74–8	Fluoroacetic acid, sodium salt
P198	23422–53–9	Formetanate hydrochloride.
P197	17702–57–7	Formparanate.
P065	628–86–4	Fulminic acid, mercury(2+) salt (R,T)
P059	76–44–8	Heptachlor
P062	757–58–4	Hexaethyl tetraphosphate
P116	79–19–6	Hydrazinecarbothioamide
P068	60–34–4	Hydrazine, methyl-
P063	74–90–8	Hydrocyanic acid
P063	74–90–8	Hydrogen cyanide
P096	7803–51–2	Hydrogen phosphide
P060	465–73–6	Isodrin
P192	119–38–0	Isolan.
P202	64–00–6	3-Isopropylphenyl N-methylcarbamate.
P007	2763–96–4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P196	15339–36–3	Manganese, bis(dimethylcarbamodithioato-S,S′)-,
P196	15339–36–3	Manganese dimethyldithiocarbamate.
P092	62–38–4	Mercury, (acetato-O)phenyl-
P065	628–86–4	Mercury fulminate (R,T)
P082	62–75–9	Methanamine, N-methyl-N-nitroso-
P064	624–83–9	Methane, isocyanato-
P016	542–88–1	Methane, oxybis[chloro-
P112	509–14–8	Methane, tetranitro- (R)
P118	75–70–7	Methanethiol, trichloro-
P198	23422–53–9	Methanimidamide, N,N-dimethyl-N′-[3-[[(methylamino)-carbonyl]oxy]phenyl]-, monohydrochloride.
P197	17702–57–7	Methanimidamide, N,N-dimethyl-N′-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-
P050	115–29–7 6,9-	P050 115–29–7 6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide

P059	76–44–8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro
P199	2032–65–7	Methiocarb.
P066	16752–77–5	Methomyl
P068	60–34–4	Methyl hydrazine
P064	624–83–9	Methyl isocyanate
P069	75–86–5	2-Methyllactonitrile
P071	298–00–0	Methyl parathion
P190	1129–41–5	Metolcarb
P128	315–8–4	Mexacarbate
P072	86–88–4	alpha-Naphthylthiourea
P073	13463–39–3	Nickel carbonyl
P073	13463–39–3	Nickel carbonyl $Ni(CO)_4$, (T-4)-
P074	557–19–7	Nickel cyanide
P074	557–19–7	Nickel cynaide $Ni(CN)_2$
P075	54–11–5	Nicotine, & salts
P076	10102–43–9	Nitric oxide
P077	100–01–6	p-Nitroaniline
P078	10102–44–0	Nitrogen dioxide
P076	10102–43–9	Nitrogen oxide NO
P078	10102–44–0	Nitrogen oxide NO_2
P081	55–63–0	Nitroglycerine (R)
P082	62–75–9	N-Nitrosodimethylamine
P084	4549–40–0	N-Nitrosomethylvinylamine
P085	152–16–9	Octamethylpyrophosphoramide
P087	20816–12–0	Osmium oxide OsO_4, (T-4)-
P087	20816–12–0	Osmium tetroxide
P088	145–73–3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P194	23135–22–0	Oxamyl.
P089	56–38–2	Parathion
P034	131–89–5	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	51–28–5	Phenol, 2,4-dinitro-
P047	534–52–1	Phenol, 2-methyl-4,6-dinitro-, & salts
P020	88–85–7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P009	131–74–8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P128	315–18–4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester)
P199	2032–65–7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
P202	64–00–6	Phenol, 3-(1-methylethyl)-, methyl carbamate
P201	2631–37–0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate
P092	62–38–4	Phenylmercury acetate
P093	103–85–5	Phenylthiourea

P094	298–02–2	Phorate
P095	75–44–5	Phosgene
P096	7803–51–2	Phosphine
P041	311–45–5	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	298–04–4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl]ester
P094	298–02–2	Phosphorodithioic acid, O,O-diethyl S-[ethylthio)methyl]ester
P044	60–51–5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	55–91–4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	56–38–2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	297–97–2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	52–85–7	Phosphorothioic acid,O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	298–00–0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
P204	57–47–6	Physostigmine.
P188	57–64–7	Physostigmine salicylate
P110	78–00–2	Plumbane, tetraethyl-
P098	151–50–8	Potassium cyanide
P098	151–50–8	Potassium cyanide K(CN)
P099	506–61–6	Potassium silver cyanide
P201	2631–37–0	Promecarb
P070	116–06–3	Propanal, 2-methyl-2-(methylthio)-,O-[(methylamino)carbonyl]oxime
P203	1646–88–4	Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime
P101	107–12–0	Propanenitrile
P027	542–76–7	Propanenitrile, 3-chloro-
P069	75–86–5	Propanenitrile, 2-hydroxy-2-methyl-
P081	55–63–0	1,2,3-Propanetriol, trinitrate (R)
P017	598–31–2	2-Propanone, 1-bromo-
P102	107–19–7	Propargyl alcohol
P003	107–02–8	2-Propenal
P005	107–18–6	2-Propen-1-ol
P067	75–55–8	1,2-Propylenimine
P102	107–19–7	2-Propyn-1-ol
P008	504–24–5	4-Pyridinamine
P075	54–11–5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts

P204	57–47–6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-,methylcarbamate (ester), (3aS-cis)-
P114	12039–52–0	Selenious acid, dithallium(1+) salt
P103	630–10–4	Selenourea
P104	506–64–9	Silver cyanide
P104	506–64–9	Silver cyanide Ag(CN)
P105	26628–22–8	Sodium azide
P106	143–33–9	Sodium cyanide
P106	143–33–9	Sodium cyanide Na(CN)
P108	57–24–9	Strychnidin-10-one, & salts
P018	357–57–3	Strychnidin-10-one, 2,3-dimethoxy-
P108	57–24–9	Strychnine, & salts
P115	7446–18–6	Sulfuric acid, dithallium(1+) salt
P109	3689–24–5	Tetraethyldithiopyrophosphate
P110	78–00–2	Tetraethyl lead
P111	107–49–3	Tetraethyl pyrophosphate
P112	509–14–8	Tetranitromethane (R)
P062	757–58–4	Tetraphosphoric acid, hexaethyl ester
P113	1314–32–5	Thallic oxide
P113	1314–32–5	Thallium oxide Tl_2O_3
P114	12039–52–0	Thallium(I) selenite
P115	7446–18–6	Thallium(I) sulfate
P109	3689–24–5	Thiodiphosphoric acid, tetraethyl ester
P045	39196–18–4	Thiofanox
P049	541–53–7	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P014	108–98–5	Thiophenol
P116	79–19–6	Thiosemicarbazide
P026	5344–82–1	Thiourea, (2-chlorophenyl)-
P072	86–88–4	Thiourea, 1-naphthalenyl-
P093	103–85–5	Thiourea, phenyl-
P185	26419–73–8	Tirpate
P123	8001–35–2	Toxaphene
P118	75–70–7	Trichloromethanethiol
P119	7803–55–6	Vanadic acid, ammonium salt
P120	1314–62–1	Vanadium oxide V_2O_5
P120	1314–62–1	Vanadium pentoxide
P084	4549–40–0	Vinylamine, N-methyl-N-nitroso-
P001	81–81–2	Warfarin, & salts, when present at concentrations greater than 0.3%
P205	137–30–4	Zinc, bis(dimethylcarbamodithioato-S,S′)-,
P121	557–21–1	Zinc cyanide
P121	557–21–1	Zinc cyanide $Zn(CN)_2$
P122	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations greater than 10% (R,T)

P205	137–30–4	Ziram.
U394	30558–43–1	A2213
U001	75–07–0	Acetaldehyde (I)
U034	75–87–6	Acetaldehyde, trichloro-
U187	62–44–2	Acetamide, N-(4-ethoxyphenyl)-
U005	53–96–3	Acetamide, N-9H-fluoren-2-yl-
U240	94–75–7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U112	141–78–6	Acetic acid ethyl ester (I)
U144	301–04–2	Acetic acid, lead(2+) salt
U214	563–68–8	Acetic acid, thallium(1+) salt
see F027	93-76-5	Acetic Acid, (2,4,5-trichlorophenoxy)-
U002	67–64–1	Acetone (I)
U003	75–05–8	Acetonitrile (I,T)
U004	98–86–2	Acetophenone
U005	53–96–3	2-Acetylaminofluorene
U006	75–36–5	Acetyl chloride (C,R,T)
U007	79–06–1	Acrylamide
U008	79–10–7	Acrylic acid (I)
U009	107–13–1	Acrylonitrile
U011	61–82–5	Amitrole
U012	62–53–3	Aniline (I,T)
U136	75–60–5	Arsinic acid, dimethyl-
U014	492–80–8	Auramine
U015	115–02–6	Azaserine
U365	2212–67–1	H-Azepine-1-carbothioic acid, hexahydro-, S-ethyl ester.
U010	50–07–7	Azirino[2′,3′:3,4]pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8bhexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta, 8aalpha, 8balpha)]-
U280	101–27–9	Barban
U278	22781–23–3	Bendiocarb
U364	22961–82–6	Bendiocarb phenol
U271	17804–35–2	Benomyl
U157	56–49–5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
U016	225–51–4	Benz[c]acridine
U017	98–87–3	Benzal chloride
U192	23950–58–5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
U018	56–55–3	Benz[a]anthracene
U094	57–97–6	Benz[a]anthracene, 7,12-dimethyl-
U012	62–53–3	Benzenamine (I,T)

U014	492–80–8	Benzenamine, 4,4′-carbonimidoylbis[N,N-dimethyl-
U049	3165–93–3	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U093	60–11–7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U328	95–53–4	Benzenamine, 2-methyl-
U353	106–49–0	Benzenamine, 4-methyl-
U158	101–14–4	Benzenamine, 4,4′-methylenebis[2-chloro-
U222	636–21–5	Benzenamine, 2-methyl-, hydrochloride
U181	99–55–8	Benzenamine, 2-methyl-5-nitro-
U019	71–43–2	Benzene (I,T)
U038	510–15–6	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U030	101–55–3	Benzene, 1-bromo-4-phenoxy-
U035	305–03–3	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U037	108–90–7	Benzene, chloro-
U221	25376–45–8	Benzenediamine, ar-methyl-
U028	117–81–7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	84–74–2	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	84–66–2	1,2-Benzenedicarboxylic acid, diethyl ester
U102	131–11–3	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	117–84–0	1,2-Benzenedicarboxylic acid, dioctyl ester
U070	95–50–1	Benzene, 1,2-dichloro-
U071	541–73–1	Benzene, 1,3-dichloro-
U072	106–46–7	Benzene, 1,4-dichloro-
U060	72–54–8	Benzene, 1,1′-(2,2-dichloroethylidene)bis[4-chloro-
U017	98–87–3	Benzene, (dichloromethyl)-
U223	26471–62–5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U239	1330–20–7	Benzene, dimethyl- (I,T)
U201	108–46–3	1,3-Benzenediol
U127	118–74–1	Benzene, hexachloro-
U056	110–82–7	Benzene, hexahydro- (I)
U220	108–88–3	Benzene, methyl-
U105	121–14–2	Benzene, 1-methyl-2,4-dinitro-
U106	606–20–2	Benzene, 2-methyl-1,3-dinitro-
U055	98–82–8	Benzene, (1-methylethyl)- (I)
U169	98–95–3	Benzene, nitro-
U183	608–93–5	Benzene, pentachloro-
U185	82–68–8	Benzene, pentachloronitro-
U020	98–09–9	Benzenesulfonic acid chloride (C,R)
U020	98–09–9	Benzenesulfonyl chloride (C,R)
U207	95–94–3	Benzene, 1,2,4,5-tetrachloro-

U061	50–29–3	Benzene, 1,1′-(2,2,2-trichloroethylidene)bis[4-chloro-
U247	72–43–5	Benzene, 1,1′-(2,2,2-trichloroethylidene)bis[4-methoxy-
U023	98–07–7	Benzene, (trichloromethyl)-
U234	99–35–4	Benzene, 1,3,5-trinitro-
U021	92–87–5	Benzidine
U202	81–07–2	1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide, & salts
U278	22781–23–3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methyl carbamate
U364	22961–82–6	1,3-Benzodioxol-4-ol, 2,2-dimethyl-,
U203	94–59–7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120–58–1	1,3-Benzodioxole, 5-(1-propenyl)-
U367	1563–38–8	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-
U090	94–58–6	1,3-Benzodioxole, 5-propyl-
U064	189–55–9	Benzo[rst]pentaphene
U248	181–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	50–32–8	Benzo[a]pyrene
U197	106–51–4	p-Benzoquinone
U023	98–07–7	Benzotrichloride (C,R,T)
U085	1464–53–5	2,2′-Bioxirane
U021	92–87–5	[1,1′-Biphenyl]-4,4′-diamine
U073	91–94–1	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dichloro-
U091	119–90–4	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethoxy-
U095	119–93–7	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethyl-
U401	97–74–5	Bis(dimethylthiocarbamoyl) sulfide.
U400	120–54–7	Bis(pentamethylene)thiuram tetrasulfide.
U225	75–25–2	Bromoform
U030	101–55–3	4-Bromophenyl phenyl ether
U128	87–68–3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	924–16–3	1-Butanamine, N-butyl-N-nitroso-
U031	71–36–3	1-Butanol (I)
U159	78–93–3	2-Butanone (I,T)
U160	1338–23–4	2-Butanone, peroxide (R,T)
U053	4170–30–3	2-Butenal
U074	764–41–0	2-Butene, 1,4-dichloro- (I,T)
U143	303–34–4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-2,3,5,7 a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1 alpha(Z),7(2S*,3R*),7aalpha]]-
U031	71–36–3	n-Butyl alcohol (I)

U392	2008–41–5	Butylate.
U136	75–60–5	Cacodylic acid
U032	13765–19–0	Calcium chromate
U372	10605–21–7	Carbamic acid, 1H-benzimidazol-2-yl, methyl ester
U271	17804–35–2	Carbamic acid, [1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]-, methyl ester.
U375	55406–53–6	Carbamic acid, butyl-, 3-iodo-2-propynyl ester
U280	101–27–9	Carbamic acid, (3-chlorophenyl)-, 4-chloro-2-butynyl ester
U238	51–79–6	Carbamic acid, ethyl ester
U178	615–53–2	Carbamic acid, methylnitroso-, ethyl ester
U373	122–42–9	Carbamic acid, phenyl-, 1-methylethyl ester
U409	23564–05–8	Carbamic acid, [1,2-phenylenebis (iminocarbonothioyl)]bis-, dimethyl ester
U097	79–44–7	Carbamic chloride, dimethyl-
U379	136–30–1	Carbamodithioic acid, dibutyl, sodium salt.
U277	95–06–7	Carbamodithioic acid, diethyl-, 2-chloro-2-propenyl ester
U381	148–18–5	Carbamodithioic acid, diethyl-, sodium salt.
U383	128–03–0	Carbamodithioic acid, dimethyl, potassium salt
U382	128–04–1	Carbamodithioic acid, dimethyl-, sodium salt.
U376	144–34–3	Carbamodithioic acid, dimethyl-, tetraanhydrosulfide with orthothioselenious acid
U378	51026–28–9	Carbamodithioic acid, (hydroxymethyl)methyl-, monopotassium salt
U384	137–42–8	Carbamodithioic acid, methyl-, monosodium salt
U377	137–41–7	Carbamodithioic acid, methyl,- monopotassium salt
U389	2303–17–5	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3,3-trichloro-2-propenyl) ester
U392	2008–41–5	Carbamothioic acid, bis(2-methylpropyl)-, S-ethyl ester
U391	1114–71–2	Carbamothioic acid, butylethyl-, S-propyl ester
U386	1134–23–2	Carbamothioic acid, cyclohexylethyl-, S-ethyl ester
U390	759–94–4	Carbamothioic acid, dipropyl-, S-ethyl ester
U387	52888–80–9	Carbamothioic acid, dipropyl-, S-(phenylmethyl) ester
U385	1929–77–7	Carbamothioic acid, dipropyl-, S-propyl ester

U114	111–54–6	Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
U062	2303–16–4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester
U279	63–25–2	Carbaryl
U372	10605–21–7	Carbendazim
U367	1563–38–8	Carbofuran phenol
U215	6533–73–9	Carbonic acid, dithallium(1+) salt
U033	353–50–4	Carbonic difluoride
U156	79–22–1	Carbonochloridic acid, methyl ester (I,T)
U033	353–50–4	Carbon oxyfluoride (R,T)
U211	56–23–5	Carbon tetrachloride
U034	75–87–6	Chloral
U035	305–03–3	Chlorambucil
U036	57–74–9	Chlordane, alpha & gamma isomers
U026	494–03–1	Chlornaphazin
U037	108–90–7	Chlorobenzene
U038	510–15–6	Chlorobenzilate
U039	59–50–7	p-Chloro-m-cresol
U042	110–75–8	2-Chloroethyl vinyl ether
U044	67–66–3	Chloroform
U046	107–30–2	Chloromethyl methyl ether
U047	91–58–7	beta-Chloronaphthalene
U048	95–57–8	o-Chlorophenol
U049	3165–93–3	4-Chloro-o-toluidine, hydrochloride
U032	13765–19–0	Chromic acid H_2CrO_4, calcium salt
U050	218–01–9	Chrysene
U393	137–29–1	Copper, bis(dimethylcarbamodithioato-S,S')-,
U393	137–29–1	Copper dimethyldithiocarbamate.
U051		Creosote
U052	1319–77–3	Cresol (Cresylic acid)
U053	4170–30–3	Crotonaldehyde
U055	98–82–8	Cumene (I)
U246	506–68–3	Cyanogen bromide (CN)Br
U386	1134–23–2	Cycloate.
U197	106–51–4	2,5-Cyclohexadiene-1,4-dione
U056	110–82–7	Cyclohexane (I)
U129	58–89–9	Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U057	108–94–1	Cyclohexanone (I)
U130	77–47–4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	50–18–0	Cyclophosphamide
U240	94–75–7	2,4-D, salts & esters
U059	20830–81–3	Daunomycin

U366	533–74–4	Dazomet.
U060	72–54–8	DDD
U061	50–29–3	DDT
U062	2303–16–4	Diallate
U063	53–70–3	Dibenz[a,h]anthracene
U064	189–55–9	Dibenzo[a,i]pyrene
U066	96–12–8	1,2-Dibromo-3-chloropropane
U069	84–74–2	Dibutyl phthalate
U070	95–50–1	o-Dichlorobenzene
U071	541–73–1	m-Dichlorobenzene
U072	106–46–7	p-Dichlorobenzene
U073	91–94–1	3,3′-Dichlorobenzidine
U074)	764–41–0	1,4-Dichloro-2-butene (I,T)
U075	75–71–8	Dichlorodifluoromethane
U078	75–35–4	1,1-Dichloroethylene
U079	156–60–5	1,2-Dichloroethylene
U025	111–44–4	Dichloroethyl ether
U027	108–60–1	Dichloroisopropyl ether
U024	111–91–1	Dichloromethoxy ethane
U081	120–83–2	2,4-Dichlorophenol
U082	87–65–0	2,6-Dichlorophenol
U084	542–75–6	1,3-Dichloropropene
U085	1464–53–5	1,2:3,4-Diepoxybutane (I,T)
U108	123–91–1	1,4-Diethyleneoxide
U028	117–81–7	Diethylhexyl phthalate
U395	5952–26–1	Diethylene glycol, dicarbamate
U086	1615–80–1	N,N′-Diethylhydrazine
U087	3288–58–2	O,O-Diethyl S-methyl dithiophosphate
U088	84–66–2	Diethyl phthalate
U089	56–53–1	Diethylstilbesterol
U090	94–58–6	Dihydrosafrole
U091	119–90–4	3,3′-Dimethoxybenzidine
U092	124–40–3	Dimethylamine (I)
U093	60–11–7	p-Dimethylaminoazobenzene
U094	57–97–6	7,12-Dimethylbenz[a]anthracene
U095	119–93–7	3,3′-Dimethylbenzidine
U096	80–15–9	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U097	79–44–7	Dimethylcarbamoyl chloride
U098	57–14–7	1,1-Dimethylhydrazine
U099	540–73–8	1,2-Dimethylhydrazine
U101	105–67–9	2,4-Dimethylphenol
U102	131–11–3	Dimethyl phthalate
U103	77–78–1	Dimethyl sulfate
U105	121–14–2	2,4-Dinitrotoluene
U106	606–20–2	2,6-Dinitrotoluene

U107	117–84–0	Di-n-octyl phthalate
U108	123–91–1	1,4-Dioxane
U109	122–66–7	1,2-Diphenylhydrazine
U110	142–84–7	Dipropylamine (I)
U111	621–64–7	Di-n-propylnitrosamine
U403.	97–77–8	Disulfiram.
U390	759–94–4	EPTC.
U041	106–89–8	Epichlorohydrin
U001	75–07–0	Ethanal (I)
U404	121–44–8	Ethanamine, N,N-diethyl-
U174	55–18–5	Ethanamine, N-ethyl-N-nitroso-
U155	91–80–5	1,2-Ethanediamine, N,N-dimethyl-N′-2-pyridinyl-N′-(2-thienylmethyl)-
U067	106–93–4	Ethane, 1,2-dibromo-
U076	75–34–3	Ethane, 1,1-dichloro-
U077	107–06–2	Ethane, 1,2-dichloro-
U131	67–72–1	Ethane, hexachloro-
U024	111–91–1	Ethane, 1,1′-[methylenebis(oxy)]bis[2-chloro-
U117	60–29–7	Ethane, 1,1′-oxybis-(I)
U025	111–44–4	Ethane, 1,1′-oxybis[2-chloro-
U184	76–01–7	Ethane, pentachloro-
U208	630–20–6	Ethane, 1,1,1,2-tetrachloro-
U209	79–34–5	Ethane, 1,1,2,2-tetrachloro-
U218	62–55–5	Ethanethioamide
U226	71–55–6	Ethane, 1,1,1-trichloro-
U227	79–00–5	Ethane, 1,1,2-trichloro-
U410	59669–26–0	Ethanimidothioic acid, N,N’-[thiobis[(methylimino)carbonyloxy]]bis-, dimethyl ester
U394	30558–43–1	Ethanimidothioic acid, 2-(dimethylamino)-N-hydroxy-2-oxo-, methyl ester.
U359	110–80–5	Ethanol, 2-ethoxy-
U173	1116–54–7	Ethanol, 2,2′-(nitrosoimino)bis-
U395	5952–26–1	Ethanol, 2,2′-oxybis-, dicarbamate.
U004	98–86–2	Ethanone, 1-phenyl-
U043	75–01–4	Ethene, chloro-
U042	110–75–8	Ethene, (2-chloroethoxy)-
U078	75–35–4	Ethene, 1,1-dichloro-
U079	156–60–5	Ethene, 1,2-dichloro-, (E)-
U210	127–18–4	Ethene, tetrachloro-
U228	79–01–6	Ethene, trichloro-
U112	141–78–6	Ethyl acetate (I)
U113	140–88–5	Ethyl acrylate (I)
U238	51–79–6	Ethyl carbamate (urethane)

U117	60–29–7	Ethyl ether (I)
U114	111–54–6	Ethylenebisdithiocarbamic acid, salts & esters
U067	106–93–4	Ethylene dibromide
U077	107–06–2	Ethylene dichloride
U359	110–80–5	Ethylene glycol monoethyl ether
U115	75–21–8	Ethylene oxide (I,T)
U116	96–45–7	Ethylenethiourea
U076	75–34–3	Ethylidene dichloride
U118	97–63–2	Ethyl methacrylate
U119	62–50–0	Ethyl methanesulfonate
U407	14324–55–1	Ethyl Ziram
U396	14484–64–1	Ferbam
U120	206–44–0	Fluoranthene
U122	50–00–0	Formaldehyde
U123	64–18–6	Formic acid (C,T)
U124	110–00–9	Furan (I)
U125	98–01–1	2-Furancarboxaldehyde (I)
U147	108–31–6	2,5-Furandione
U213	109–99–9	Furan, tetrahydro-(I)
U125	98–01–1	Furfural (I)
U124	110–00–9	Furfuran (I)
U206	18883–66–4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-,
DU206	18883–66–4	D-Glucose, 2-deoxy-2-[[(methylnitrosoamino)-carbonyl]amino]-
U126	765–34–4	Glycidylaldehyde
U163	70–25–7	Guanidine, N-methyl-N′-nitro-N-nitroso-
U127	118–74–1	Hexachlorobenzene
U128	87–68–3	Hexachlorobutadiene
U130	77–47–4	Hexachlorocyclopentadiene
U131	67–72–1	Hexachloroethane
U132	70–30–4	Hexachlorophene
U243	1888–71–7	Hexachloropropene
U133	302–01–2	Hydrazine (R,T)
U086	1615–80–1	Hydrazine, 1,2-diethyl-
U098	57–14–7	Hydrazine, 1,1-dimethyl-
U099	540–73–8	Hydrazine, 1,2-dimethyl-
U109	122–66–7	Hydrazine, 1,2-diphenyl-
U134	7664–39–3	Hydrofluoric acid (C,T)
U134	7664–39–3	Hydrogen fluoride (C,T)
U135	7783–06–4	Hydrogen sulfide
U135	7783–06–4	Hydrogen sulfide H_2S
U096	80–15–9	Hydroperoxide, 1-methyl-1-phenylethyl- (R)
U116	96–45–7	2-Imidazolidinethione
U137	193–39–5	Indeno[1,2,3-cd]pyrene

U375	55406–53–6	3-Iodo-2-propynyl n-butylcarbamate
U396	14484–64–1	Iron, tris(dimethylcarbamodithioato-S,S′)-,
U190	85–44–9	1,3-Isobenzofurandione
U140	78–83–1	Isobutyl alcohol (I,T)
U141	120–58–1	Isosafrole
U142	143–50–0	Kepone
U143	303–34–4	Lasiocarpine
U144	301–04–2	Lead acetate
U146	1335–32–6	Lead, bis(acetato-O)tetrahydroxytri-
U145	7446–27–7	Lead phosphate
U146	1335–32–6	Lead subacetate
U129	58–89–9	Lindane
U163	70–25–7	MNNG
U147	108–31–6	Maleic anhydride
U148	123–33–1	Maleic hydrazide
U149	109–77–3	Malononitrile
U150	148–82–3	Melphalan
U151	7439–97–6	Mercury
U384	137–42–8	Metam Sodium.
U152	126–98–7	Methacrylonitrile (I, T)
U092	124–40–3	Methanamine, N-methyl- (I)
U029	74–83–9	Methane, bromo-
U045	74–87–3	Methane, chloro- (I, T)
U046	107–30–2	Methane, chloromethoxy-
U068	74–95–3	Methane, dibromo-
U080	75–09–2	Methane, dichloro-
U075	75–71–8	Methane, dichlorodifluoro-
U138	74–88–4	Methane, iodo-
U119	62–50–0	Methanesulfonic acid, ethyl ester
U211	56–23–5	Methane, tetrachloro-
U153	74–93–1	Methanethiol (I, T)
U225	75–25–2	Methane, tribromo-
U044	67–66–3	Methane, trichloro-
U121	75–69–4	Methane, trichlorofluoro-
U036	57–74–9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U154	67–56–1	Methanol (I)
U155	91–80–5	Methapyrilene
U142	143–50–0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U247	72–43–5	Methoxychlor
U154	67–56–1	Methyl alcohol (I)
U029	74–83–9	Methyl bromide
U186	504–60–9	1-Methylbutadiene (I)

U045	74–87–3	Methyl chloride (I,T)
U156	79–22–1	Methyl chlorocarbonate (I,T)
U226	71–55–6	Methyl chloroform
U157	56–49–5	3-Methylcholanthrene
U158	101–14–4	4,4′-Methylenebis(2-chloroaniline)
U068	74–95–3	Methylene bromide
U080	75–09–2	Methylene chloride
U159	78–93–3	Methyl ethyl ketone (MEK) (I,T)
U160	1338–23–4	Methyl ethyl ketone peroxide (R,T)
U138	74–88–4	Methyl iodide
U161	108–10–1	Methyl isobutyl ketone (I)
U162	80–62–6	Methyl methacrylate (I,T)
U161	108–10–1	4-Methyl-2-pentanone (I)
U164	56–04–2	Methylthiouracil
U010	50–07–7	Mitomycin C
U365	2212–67–1	Molinate
U059	20830–81–3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-
U167	134–32–7	1-Naphthalenamine
U168	91–59–8	2-Naphthalenamine
U026	494–03–1	Naphthalenamine, N,N′-bis(2-chloroethyl)-
U165	91–20–3	Naphthalene
U047	91–58–7	Naphthalene, 2-chloro-
U166	130–15–4	1,4-Naphthalenedione
U236	72–57–1	2,7-Naphthalenedisulfonic acid, 3,3′-[(3,3′-dimethyl[1,1’-biphenyl]-4,4’-diyl)bis(azo)bis[5-amino-4-hydroxyl]-, tetrasodium salt
U279	63–25–2	1-Naphthalenol, methylcarbamate
U166	130–15–4	1,4-Naphthoquinone
U167	134–32–7	alpha-Naphthylamine
U168	91–59–8	beta-Naphthylamine
U217	10102–45–1	Nitric acid, thallium(1+) salt
U169	98–95–3	Nitrobenzene (I,T)
U170	100–02–7	p-Nitrophenol
U171	79–46–9	2-Nitropropane (I,T)
U172	924–16–3	N-Nitrosodi-n-butylamine
U173	1116–54–7	N-Nitrosodiethanolamine
U174	55–18–5	N-Nitrosodiethylamine
U176	759–73–9	N-Nitroso-N-ethylurea
U177	684–93–5	N-Nitroso-N-methylurea
U178	615–53–2	N-Nitroso-N-methylurethane
U179	100–75–4	N-Nitrosopiperidine
U180	930–55–2	N-Nitrosopyrrolidine

U181	99–55–8	5-Nitro-o-toluidine
U193	1120–71–4	1,2-Oxathiolane, 2,2-dioxide
U058	50–18–0	2H-1,3,2-Oxazaphosphorin-2-amine,N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U115	75–21–8	Oxirane (I,T)
U126	765–34–4	Oxiranecarboxyaldehyde
U041	106–89–8	Oxirane, (chloromethyl)-
2	123–63–7	Paraldehyde
U391	1114–71–2	Pebulate.
U183	608–93–5	Pentachlorobenzene
U184	76–01–7	Pentachloroethane
U185	82–68–8	Pentachloronitrobenzene (PCNB)
See F027	87–86–5	Pentachlorophenol
U161	108–10–1	Pentanol, 4-methyl-
U186	504–60–9	1,3-Pentadiene (I)
U187	62–44–2	Phenacetin
U188	108–95–2	Phenol
U048	95–57–8	Phenol, 2-chloro-
U039	59–50–7	Phenol, 4-chloro-3-methyl-
U081	120–83–2	Phenol, 2,4-dichloro-
U082	87–65–0	Phenol, 2,6-dichloro-
U089	56–53–1	Phenol, 4,4′-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U101	105–67–9	Phenol, 2,4-dimethyl-
U052	1319–77–3	Phenol, methyl-
U132	70–30–4	Phenol, 2,2′-methylenebis[3,4,6-trichloro-
U411	114–26–1.	Phenol, 2-(1-methylethoxy)-, methylcarbamate.
U170	100–02–7	Phenol, 4-nitro-
See F027	87–86–5	Phenol, pentachloro-
See F027	58–90–2	Phenol, 2,3,4,6-tetrachloro-
See F027	95-95-4	Phenol, 2,4,5-trichloro-
See F027	88–06–2	Phenol, 2,4,6-trichloro-
U150	148–82–3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U145	7446–27–7	Phosphoric acid, lead(2+) salt (2:3)
U087	3288–58–2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U189	1314–80–3	Phosphorus sulfide (R)
U190	85–44–9	Phthalic anhydride
U191	109–06–8	2-Picoline
U179	100–75–4	Piperidine, 1-nitroso-
U400	120–54–7	Piperidine, 1,1′-(tetrathiodicarbonothioyl)-bis-
U383	128–03–0	Potassium dimethyldithiocarbamate
U378	51026–28–9	Potassium n-hydroxymethyl- n-methyldi-thiocarbamate

U377	137–41–7	Potassium n-methyldithiocarbamate
U192	23950–58–5	Pronamide
U194	107–10–8	1-Propanamine (I,T)
U111	621–64–7	1-Propanamine, N-nitroso-N-propyl-
U110	142–84–7	1-Propanamine, N-propyl- (I)
U066	96–12–8	Propane, 1,2-dibromo-3-chloro-
U083	78–87–5	Propane, 1,2-dichloro-
U149	109–77–3	Propanedinitrile
U171	79–46–9	Propane, 2-nitro- (I,T)
U027	108–60–1	Propane, 2,2′-oxybis[2-chloro-
U193	1120–71–4	1,3-Propane sultone
See F027	93–72–1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
U235	126–72–7	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U140	78–83–1	1-Propanol, 2-methyl- (I,T)
U002	67–64–1	2-Propanone (I)
U007	79–06–1	2-Propenamide
U084	542–75–6	1-Propene, 1,3-dichloro-
U243	1888–71–7	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	107–13–1	2-Propenenitrile
U152	126–98–7	2-Propenenitrile, 2-methyl- (I,T)
U008	79–10–7	2-Propenoic acid (I)
U113	140–88–5	2-Propenoic acid, ethyl ester (I)
U118	97–63–2	2-Propenoic acid, 2-methyl-, ethyl ester
U162	80–62–6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U373	122–42–9	Propham
U411	114–26–1	Propoxur
U387	52888–80–9	Prosulfocarb
U194	107–10–8	n-Propylamine (I,T)
U083	78–87–5	Propylene dichloride
U148	123–33–1	3,6-Pyridazinedione, 1,2-dihydro-
U196	110–86–1	Pyridine
U191	109–06–8	Pyridine, 2-methyl-
U237	66–75–1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U164	56–04–2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	930–55–2	Pyrrolidine, 1-nitroso-
U200	50–55–5	Reserpine
U201	108–46–3	Resorcinol
U202	81–07–2	Saccharin, & salts
U203	94–59–7	Safrole
U204	7783–00–8	Selenious acid
U204	7783–00–8	Selenium dioxide
U205	7488–56–4	Selenium sulfide

U205	7488–56–4	Selenium sulfide SeS_2 (R,T)
U376	144–34–3	Selenium, tetrakis(dimethyldithiocarbamate)
U015	115–02–6	L-Serine, diazoacetate (ester)
See F027	93–72–1	Silvex (2,4,5-TP)
U379	136–30–1	Sodium dibutyldithiocarbamate.
U381	148–18–5	Sodium diethyldithiocarbamate
U382	128–04–1	Sodium dimethyldithiocarbamate
U206	18883–66–4	Streptozotocin
U103	77–78–1	Sulfuric acid, dimethyl ester
U277	95–06–7	Sulfallate
U189	1314–80–3	Sulfur phosphide (R)
See F027	2,4,5-T	2,4,5-T
U402	1634–02–2	Tetrabutylthiuram disulfide
U207	95–94–3	1,2,4,5-Tetrachlorobenzene
U208	630–20–6	1,1,1,2-Tetrachloroethane
U209	79–34–5	1,1,2,2-Tetrachloroethane
U210	127–18–4	Tetrachloroethylene
See F027	58–90–2	2,3,4,6-Tetrachlorophenol
U213	109–99–9	Tetrahydrofuran (I)
U401	97–74–5	Tetramethylthiuram monosulfide
U214	563–68–8	Thallium(I) acetate
U215	6533–73–9	Thallium(I) carbonate
U216	7791–12–0	Thallium(I) chloride
U216	7791–12–0	Thallium chloride Tlcl
U217	10102–45–1	Thallium(I) nitrate
U366	533–74–4	2H-1,3,5-Thiadiazine- 2-thione, tetrahydro-3,5-dimethyl-
U218	62–55–5	Thioacetamide
U410	59669–26–0	Thiodicarb.
U153	74–93–1	Thiomethanol (I,T)
U244	137–26–8	Thioperoxydicarbonic diamide $[(H_2N)C(S)]_2S_2$, tetramethyl-
U402	1634–02–2	Thioperoxydicarbonic diamide, tetrabutyl
U403	97–77–8	Thioperoxydicarbonic diamide, tetraethyl
U409	23564–05–8	Thiophanate-methyl
U219	62–56–6	Thiourea
U244	137–26–8	Thiram
U220	108–88–3	Toluene
U221	25376–45–8	Toluenediamine
U223	26471–62–5	Toluene diisocyanate (R,T)
U328	95–53–4	o-Toluidine
U353	106–49–0	p-Toluidine
U222	636–21–5	o-Toluidine hydrochloride
U389	2303–17–5	Triallate
U011	61–82–5	1H-1,2,4-Triazol-3-amine

U227	79–00–5	1,1,2-Trichloroethane
U228	79–01–6	Trichloroethylene
U121	75–69–4	Trichloromonofluoromethane
See F027	2,4,5-Trichlorophenol	2,4,5-Trichlorophenol
See F027	88–06–2	2,4,6-Trichlorophenol
U404	121–44–8	Triethylamine.
U234	99–35–4	1,3,5-Trinitrobenzene (R,T)
U182	123–63–7	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	126–72–7	Tris(2,3-dibromopropyl) phosphate
U236	72–57–1	Trypan blue
U237	66–75–1	Uracil mustard
U176	759–73–9	Urea, N-ethyl-N-nitroso-
U177	684–93–5	Urea, N-methyl-N-nitroso-
U385	1929–77–7	Vernolate
U043	75–01–4	Vinyl chloride
U248	81–81–2	Warfarin, & salts, when present at concentrations of 0.3% or less
U239	1330–20–7	Xylene (I)
U200	50–55–5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-,methyl ester, (3beta,16beta,17alpha,18beta,20alpha)-
U407	14324–55–1	Zinc, bis(diethylcarbamodithioato-S,S')-
U249	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations of 10% or less

Appendix F

Glove Selection Chart

The times listed below are average breakthrough times for each type of glove, i.e. the minimum time that it will take for a given chemical compound to break through the glove material.

Chemical Name	Nitrile	PVC	Neoprene	Butyl	Comments
Acetic Acid, Glacial	4.5 hr	3 hr	7 hr	NR	
Acetone	NR	NR	10 min	> 17 hr	
Acetonitrile	30 min	NR	30 min	> 8 hr	
Ammonium Hydroxide, conc.	> 8 hr	4 hr	> 6 hr	NR	
Aniline	72 min	3 hr	35 min	> 8 hr	
Benzene	9 min	13 min	16 min	31 min	
Carbon Disulfide	20 min	NR	NR	< 4min	
Carbon Tetrachloride	2.5 hr	25 min	31 min	NR	
Chloroform	NR	10 min	12 min	NR	
Chromic Acid, 50%	4 hr	NR	NR	NR	
Dichloroethane	16 min	NR	33 min	2 hr	
Dimethyl Formamide	35 min	NR	10 min	> 8 hr	
Ethanol	> 8 hr	1 hr	1.5 hr	NR	
Ethyl Ether	64 min	14 min	10 min	8 min	
Formaldehyde, 37%	> 8 hr	80 min	2 hr	16 hr	
Hexane	> 8 hr	29 min	39 min	4 min	
Hydrochloric Acid, conc.	> 8 hr	NR	> 8 hr	NR	
Isopropanol	> 8 hr	2.5 hr	1.5 hr	NR	
Methylene Chloride	NR	NR	6 min	20 min	
Methyl Ethyl Ketone (MEK)	> 24 hr	12 min	22 min	> 6 hr	
Nitric Acid, conc.	NR	NR	2 hr	NR	
Phenol	> 8 hr	2.5 hr	3 hr	> 20 hr	
Sodium Hydroxide, 50%	> 8 hr	NR	> 8 hr	NR	
Sulfuric Acid, conc.	NR	3 hr	3 hr	NR	
Tetrahydrofuran	NR	NR	NR	NR	use PVA
Trichloroethane	90 min	52 min	27 min	NR	
Toluene	10 min	19 min	6 min	21 min	
Xylene	75 min	23 min	23 min	NR	

PVA = Polyvinyl Alcohol, a special-use glove that provides good protection against many solvents, but dissolves in water! Therefore, it is not recommended for general laboratory use.

NR = Not Recommended

- Latex gloves do not provide adequate protection from most chemicals
- Remember that no glove is good for an indefinite period of time.
- Check gloves after each use for degradation, tears, punctures, or swelling.
- If there is any question regarding the glove's integrity, discard it.
- Wash and dry gloves thoroughly after each use.

Appendix G
Chemical Storage – Incompatible Chemicals

Certain hazardous chemicals should not be mixed or stored with other chemicals because a severe reaction can take place or an extremely toxic reaction product can result. The label and MSDS will contain information on incompatibilities. The following table contains examples of incompatible chemicals:

CHEMICAL	KEEP OUT OF CONTACT WITH
Acetic Acid	Chromic acid, nitric acid hydroxyl compounds, ethylene, glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali Metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the halogens
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	Same as chlorine
Calcium Oxide	Water
Carbon (activated)	Calsium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic Acid	Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene Hydroperoxide	Acids, organic or inorganic
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic Acid	Nitric acid, alkali
Hydrofluoric Acid	Ammonia, aqueous or anhydrous

Hydrogen Peroxide	Copper, chromium, iron, most metals or thei salts, alcohols, acetone, organic materials, aniline, nitomethane, flammable liquids, oxidizing gases
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases, acetylene, ammonia (aqueous or anhydrous), hydrogen
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic Acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium Chlorate	Sulfuric and other acids
Potassium Permanganate	Glycerine, ethlylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium Peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc…)
Tellurides	Reducing agents

CHEMICAL SPILLS AND ACCIDENTS

Try to anticipate the types of chemical spills that can occur in your laboratory and obtain the necessary equipment (spill kits and personal protective equipment) to respond to a minor spill. Learn how to safely clean up minor spills of chemicals you use regularly. A MSDS contains special clean-up information and should be consulted. ***Chemical spills should only be cleaned up by knowledgeable and experienced personnel.***

If the spill is too large for you to handle, is a threat to personnel, students, or the public, or involves a highly toxic or reactive chemical, call for assistance immediately by dialing **811**.

The following materials are very hazardous. **You should not clean them up yourself.**

- -Aromatic amines
- -Bromine
- -Carbon disulfide
- -Cyanides
- -Ethers and other 1A flammable solvents
- -Hydrazine
- -Organic Halides
- -Nitriles
- -Nitro compounds

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